WATER WORKS & SEWERAGE

L. H. ENSLOW, Editor

LEADING ARTICLES To Appear in the Next and Subsequent Issues:

"Bleaching Clay in Water Purification" by George D. Norcom, Sanitary Engineer of the Utility Service Staff Corporation, recounts experiences with absorbent clays in waste removal from an industrially polluted water supply coming under the author's supervision. "Water *Supply* Practice on Railroads" is the title of an article in this issue by R. C. Bardwell, Superintendent of Water Supply of the Chesapeake & Ohio Railway System. Next, Mr. Bardwell will contribute a follow-up article describing "Water *Treatment* Practice on Railway Systems," in which the most up-to-the-minute methods used in treating water, for railway use, under a variety of circumstances will be described and discussed.

Robert B. Morse, Chief Engineer, Washington Suburban Sanitary District, Hyattsville, Md., will contribute an article disclosing methods and practice pursued during new trunk sewer construction, wherein cast iron pipe was employed, based upon the low comparative cost of materials plus construction costs to complete the project. The use of 18-foot lengths of centrifugally spun pipe for house connections offers peculiar advantages also to be set forth.

"Double Pumping—In and Out of Storage" by W. Compton Wills, Chief Engineer of the Water Department at Wilmington, Del., will describe an economical pumping scheme for delivery of surplus water from one source of supply to a new storage reservoir constructed on an adjoining water shed. The raw water in turn is repumped from storage back to the stream from which taken at a point above the filtration plant during periods of low flow. The problem was intricate and its solution ingenious.

"Large Scale Experiments on Sewage Sludge Digestion" by C. E. Keefer, Engineer in Charge of Sewage Treatment Works, Baltimore, Md., sets forth a comparison of results procured by heating sludge digestors by direct hot water application versus hot water pipe coils. The advantages and disadvantages of each procedure are discussed by Mr. Keefer.

Herbert H. Brown, Engineer in Charge of Design and Construction, Department of Public Works, Milwaukee, Wis., will describe the unique method of securing scattered storage of water at important points on the Milwaukee distribution system. Very large ground storage tanks of 6,000,000 gallons' capacity and automatic booster pumps constitute the major units of the "distributed storage" scheme. Smaller elevated tanks supplement it.

E. T. Cranch, Superintendent, New Rochelle Water Company, New York, will continue with a series of articles on water works maintenance and operating problems. The next article will deal with maintenance and repairs of fire hydrants.

Vol. LXXIX, No. 12

CONTENTS for DECEMBER 1932

Railway Water Supply Practice 403
By R. C. BARDWELL
Superintendent of Water Supply, Chesapeake & Ohio Railway System, Richmond, Va.

Experiences with Water Main Cleaning 407
By ARTHUR T. CLARK
Manager, Greenwich Water Co., Greenwich, Conn.

Meeting of North Carolina Section of A. W. W. A. and North Carolina Sewage Works Association 411

Meeting of Virginia Water and Sewage Works Association 416

A New Chemical Sewage Purification Process 420
By E. A. CAPPELEN SMITH

Missouri Water and Sewerage Conference 423

Procedure for Making Odor and Taste Determinations 425
By JOHN R. BAYLIS
Physical Chemist, Bureau of Engineering, Chicago, Ill.

Evaporation As a Process of Reclamation and Prevention of Stream Pollution 427
By H. O. CHUTE
Chemical Engineer

Economic Replacement of Pumping Equipment 430
By H. P. BINDER
Engineer, Allis-Chalmers Mfg. Co.

Sewage Treatment at High Point, N. C. 433
By E. H. MOSS and C. W. MENGEL

Editorials 439

Published monthly by the GILLETTE PUBLISHING CO., Daily News Building, Chicago, Ill.

Entered as Second Class Matter, June 2, 1931, at the Post Office at Chicago, Ill., under the Act of March 3, 1879. Published monthly at 400 W. Madison Street, Chicago, Ill Per copy 25c. Subscription rates $2.00 per year. Canadian and Foreign, $3.00 per year. Copyright, 1932, by Gillette Publishing Company, Publishers of: Engineering and Contracting, Water Works and Sewerage, Roads and Streets, Oil and Soap, Motive Power, The Art of Mosaics and Terrazzo, Road and Street Catalog and Data Book, Water Works Catalog and Data Book.

HALBERT P. GILLETTE, Pres. and Editor in Chief; E. S. GILLETTE, Vice-Pres. and Secretary; E. B. HOWE, Vice-President; E. C. KELLY, Vice-President; J. M. ANGELL, JR., Eastern Manager; L. H. ENSLOW, 420 Lexington Ave., New York, N. Y., Editor; C. T. MURRAY, Managing Editor; V. J. BROWN, Associate Editor; JOHN R. BAYLIS, Associate Editor; D. G. LEDGERWOOD, Make-Up Editor.

Chicago Office, Daily News Building. Cleveland Office, 953 Leader Bldg. New York Office, 420 Lexington Ave. San Francisco Office, 703 Market Street.

Addresses will be changed as frequently as desired, upon notification; not otherwise. Changes of address should be sent in at least two weeks before the date of the next issue of *Water Works and Sewerage*, in order for them to be effective for that number. Immediate notice should be given of any delay in the receipt of the magazine.

ADVERTISERS IN THIS ISSUE

A

Alvord, Burdick & Howson..... 50

B

Black & Veatch..... 50
Burns & McDonnell Engr. Co..... 50

C

Chester Engrs., J. N., The..... 50
Chicago Testing Laboratory..... 50
Chute, H. O..... 50
Clark, Wm. G..... 50
Cleveland, H. Burdett..... 50

D

Dorr Co., Inc., The.....Third Cover
Dow, A. W..... 50

F

Filclor Company, The..... 49
Filtration Equipment Corp..... 47
Fowler, Chas. Evan..... 50
Fuller & McClintock..... 50

G

Gascoigne, Geo. B..... 50
Gillette Publishing Co..... 6
Gordon & Bulot..... 50

H

Hall, B. M., & Sons..... 50
Hill, Nicholas S., Jr..... 50

I

Industrial Chemical Sales Co., Inc..... 5

J

Jennison-Wright Co., The..... 8

K

Kimberly, A. Elliott..... 50
Knowles, Inc., Morris..... 50

L

Lock Joint Pipe Co..... 49

M

McWane Cast Iron Pipe Co..... 49
Metcalf & Eddy..... 50

N

National Water Main Cleaning Co..... 49

P

Pacific States Cast Iron Pipe Co..... 49
Pennsylvania Salt Mfg. Co..... 7
Phipps & Bird, Inc.....Second Cover
Pirnie, Malcolm 50
Potter, Alexander 50
Powell, Sheppard T..... 50

R

Randolph-Perkins Co. 50
Roberts Filter Mfg. Co..... 49
Rosing, Astrid S., Inc..... 50

S

Simplex Valve & Meter Co..... 47
South Bend Foundry Co..... 49
Stewart, W. H..... 48

T

Taylor Audit Co., P. H..... 50

W

Wallace & Tiernan.....Back Cover

PEACE on EARTH

...the year 'round!

WHAT does Christmas mean to you? Holly and mistletoe . . . the home-coming of dear ones . . . greetings and feasting . . . a glistening tree decked with fairy lights and bending with gifts . . . children's happy laughter . . . contentment and peace . . . Whatever joy it brings you individually we wish you in abundant measure. May the cheery spirit of this season last through the coming year and be still more abundantly renewed at Christmases to come.

INDUSTRIAL CHEMICAL SALES COMPANY, INC.

230 PARK AVENUE
NEW YORK

205 W. WACKER DRIVE
CHICAGO

POWDERED ACTIVATED AQUA NUCHAR AQUA CARBON

Announcing a NEW BOOK

that every water works operator should have

WATER PURIFICATION CONTROL

I COAGULATION
Time of Mixing, Floc Characteristics, pH Control, Color Removal, Iron and Lime Coagulation, Use of Sodium Aluminate, Manganese, Coagulation Control.

II SEDIMENTATION
Effect of Settling on Plant Control, Cross-Baffled Basins.

III FILTRATION
Filter Beds, Rate Controllers, Filter Washing, Care of Filter Beds, Mud Deposit Formation, Sand Grading, Air Binding, Sand Cleaning, Filter Control Records.

IV DISINFECTION
Chlorination, Ultra Violet Ray and Ozone Treatment.

V TASTES AND ODORS
Superchlorination, Chloramines, Activated Carbon, Aeration, Permanganate, Algae Control.

VI CORRECTIVE TREATMENT
pH Control, Effect of Corrective Treatment.

VII PLANT CONTROL DATA
Standards of Purity.

$1.75
POST PAID

A Short, Non-Technical, Informative, Practical Handbook and Guide for the Plant Operator

By
EDWARD S. HOPKINS
Principal Sanitary Chemist, Bureau of Water Supply, Baltimore, Md.

THIS is a handbook for which there has been genuine need in the water-works field for a number of years. Its audience is the plant operator. It is particularly designed to meet his needs. It is a book of simple discussion and simple directions. It aims to present the practical, usable facts in systematic form.

ABEL WOLMAN SAYS: "The number of texts of a purely operating character is decidedly limited. Those that are good are somewhat out of date, and therefore, this volume fills a current need.

"No matter how well designed a water treatment plant may be, its product is dependent to a great degree upon the efficiency of the man operating it. To improve and guide the operator is the primary function of this book. It is designed, in simplicity of language and arrangement, to meet the needs of the rank and file. It should lighten the load on many control agencies and should stimulate the already conscientious operator, whose task is so well done and so rarely given public recognition, to higher levels of performance. The book should be on each operator's desk."

—Excerpts from the Foreword

USE THE COUPON

WATER WORKS AND SEWERAGE
400 W. Madison St., Chicago, Ill.

Gentlemen:

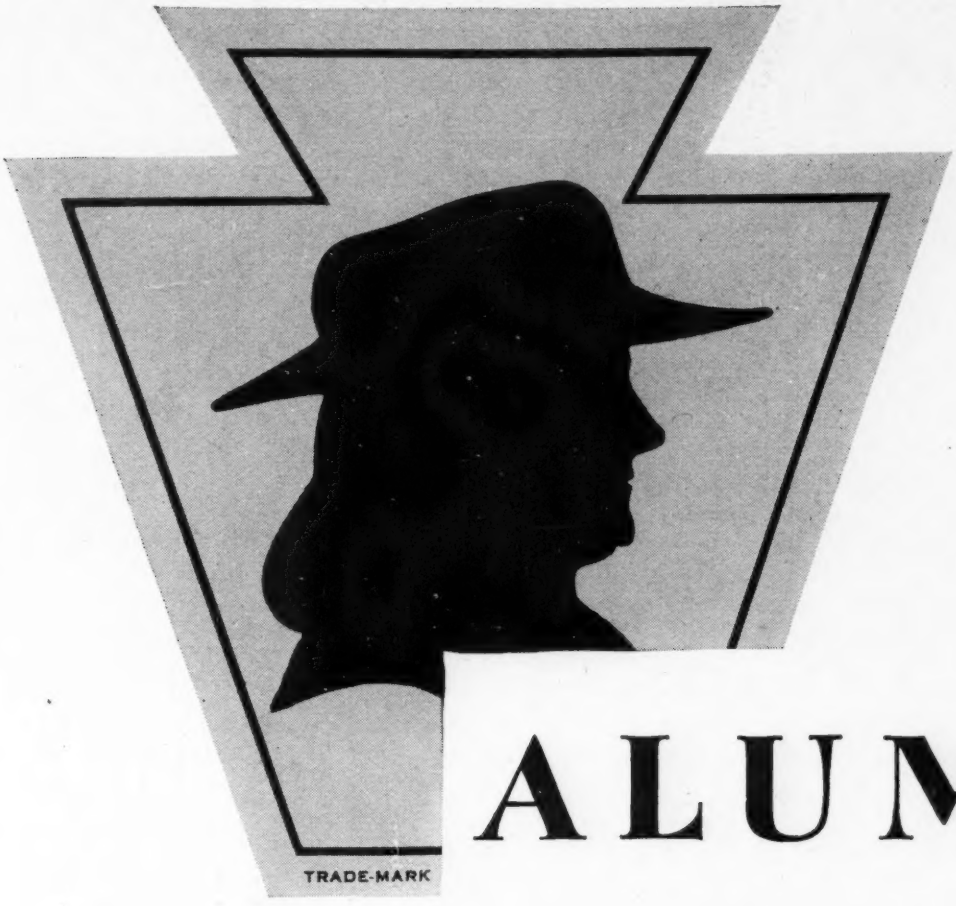
Please mail me a copy of WATER PURIFICATION CONTROL. My check or money order for $1.75 is enclosed.

NAME .....

POSITION .....

12-32

ADDRESS .....



ALUM

The Pennsylvania Salt Manufacturing Company were the pioneers in manufacturing iron-free alum for use in paper making. They were also the first to introduce porous alum to the paper industry. These are only two of the many products made by this organization for industrial purposes.

Chemicals for Industry

CAUSTIC SODA
BLEACHING POWDER
CHLORINE
ACIDS

Est. 1850 TRADE MARK

PENNSYLVANIA SALT MFG. CO.

EXECUTIVE OFFICES, WIDENER BLDG., PHILADELPHIA, PENNA.

Branch Sales Offices: New York, Pittsburgh, Chicago, St. Louis, Wyandotte, Mich., and Tacoma, Wash.

Works: Philadelphia and Natrona, Pa.: Wyandotte and Menominee. Mich.: Tacoma, Wash., Tacoma Electrochemical Co.

Do you mention WATER WORKS AND SEWERAGE when writing? Please do.

A SIMPLE laboratory test will vividly reveal what Klearit will do for you in actual use.

The power of this activated pure hard carbon to remove bad taste, offensive odors, and to clarify and purify water is absolutely and inevitably positive.

Klearit not only improves the result of filtration processes, but speeds the operation in many ways. It is the long-desired necessary complement to any water purification operation. You owe it to your plant, to your consumers, and to yourself to learn all about it. We will gladly cooperate with an ample specimen of the material and specialized engineering data on your particular application. Request this valuable free service.

THE JENNISON-WRIGHT COMPANY
TOLEDO, OHIO
Branches in All Large Cities

KLEARIT

Yes—we would like you to mention WATER WORKS AND SEWERAGE.

WATER WORKS AND SEWERAGE

DEC. 1932

No. 12

VOL. 79

A GILLETTE PUBLICATION

RAILWAY WATER SUPPLY PRACTICE

By R. C. BARDWELL

Superintendent of Water Supply,
Chesapeake and Ohio Railway System,
Richmond, Va.

R. C. Bardwell

THE development of American railroads into the world's greatest transportation industry had as an important prerequisite an adequate and suitable supply of water. Problems in railway water supply have been varied and of considerable importance in the economics directly affecting train movement as well as maintenance of equipment and operating costs. A definite amount of water is required for every mile run by each of the 60,000 locomotives which are mobile steam power plants varying from 500 to 5,000 horse power. Suitable water must be provided when and where required on the 250,000 miles of road in order that there may be no interruption in the movement of traffic which, in normal times, will amount to 1,000,000 gross ton miles and about 26,000,000 passenger miles.

It is seldom realized that railroads use, both in volume and weight, more water than all other supplies and commodities added together. The total water consumption for all purposes during normal times is in excess of 500,000,000,000 gallons per year of which 350,000,000,000 gallons are required for making steam. Although the cost of furnishing this water is only about one per cent of railroad operating expense, the total annual cost will average $50,000,000, exclusive of interest and depreciation, to provide suitable water for what has been aptly termed "the delicate stomach of the Iron Horse."*

About 18,000 water stations are required to supply this water and it is indicated that the cost of replacement would be in excess of $400,000,000. Over 20,000 pumps are used with varied and extensive power units, forcing the water through many thousand miles of pipe lines. There are approximately 25,000 storage tanks in service.

Water Supply, Maintenance and Operation

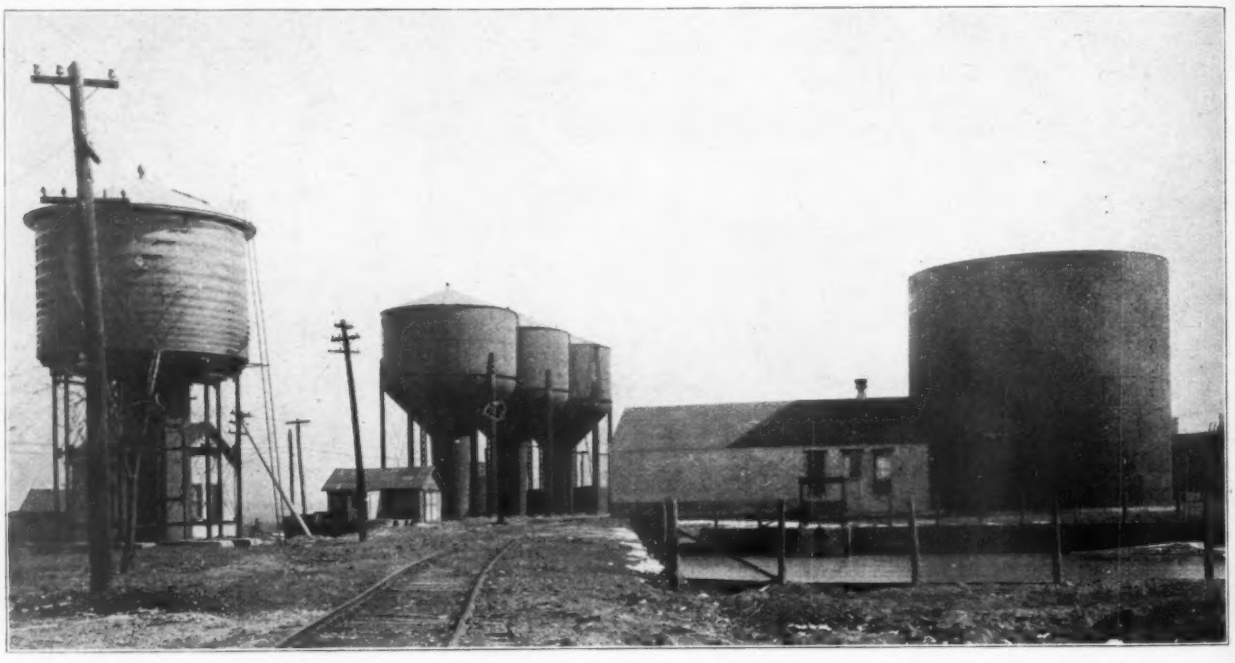
Many different methods are followed by railroads in handling their water supply, which may be accounted for by the fact that the comparatively recent curtailment in the building of new railway lines and extensions, has focused attention on the consideration of all possible economies. Length and speed of freight trains has been increased and larger locomotives are in service

The author of this paper is an authority in railway water supply practices and the treatment of waters for railroad use. He has served for several years as chairman of the Water Service Committee of the American Railway Association and through his committee work in the American Water Works Association has contributed materially to the development of laboratory control procedures and water treatment practice.—Editor.

*See Front Cover.

which handle train loads as high as 15,000 tons and the train length frequently reaches 200 cars. These larger locomotives are equipped with tender storage tanks of more than 23,000 gallon capacity made necessary because of increased water consumption and also to reduce the frequency of stops for water takings. This large tender storage permits selection of better quality supplies, thus avoiding usage of inferior quality waters. This facility is of importance in the extension of engine runs over more than one district which now, in some cases, exceeds 900 miles continuous service with engine crews changed at division terminals. Steam pressures have been increased and 250 lbs. per square inch is now quite common.

Water stations are usually designed by the Engineering Departments, operated by the Maintenance Forces and used by the Mechanical Department. Since the results affect general operation it has been found advisable on many railroads to materially reduce the divided responsibility by the establishment of a Water Department in keeping with the recommended practice of the American Railway Engineering Association. This entails the appointment of an experienced Water Supply Engineer on the general office staff with such assistance as is required by local conditions. The Water Supply Engineer is charged with the responsibility for the design and installation of new units as well as the supervision of general water works operation, maintenance, and standards in order to obtain maximum economies. Complete records must be kept available and up to date, of the widely scattered facilities. Operating and maintenance reports must be faithfully checked to avoid waste and unnecessary expense.



Storage Tanks on the Chicago & North Western Railway at Well on the C. & O. Ry. at Russell, Ky.

Sources of Supply

One of the general recommendations of the American Railway Engineering Association is that—"When water of suitable quality and in sufficient quantity can be purchased at reasonable cost, it is recommended above all other sources." This is in line with the general spirit of cooperation between railroads and the municipalities in which the railroad corporation is frequently one of the largest taxpayers. Where such arrangements can be satisfactorily consummated, it is frequently to the advantage of both parties because the railroad consumption is usually regular and a large part may be taken during the off-peak municipal load, i. e., during a period when the normal draught on the system is at a low rate. One of the main disadvantages frequently encountered is the unsatisfactory quality of the municipal water supply which, although being entirely satisfactory for use in domestic consumption, frequently does not meet the standards for a suitable boiler water without further treatment. This requires additional facilities and treatment by the railroad and it usually is found that the railway company can secure a source of supply and provide pumping and production to deliver a suitable water at a much less cost than the price charged for water supplied by the municipality.

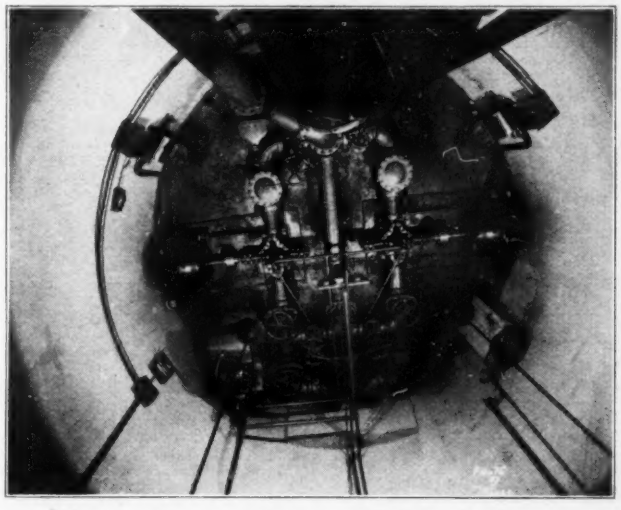
Most of the railroad water stations are at outlying points where it is necessary to develop a supply for their individual needs. A large per cent of these supplies are obtained from surface waters but in many cases it is necessary to resort to wells. Where streams are used, there is a considerable fluctuation in quality and the variation in river stages occasionally requires special attention to the pumping problem. Along the Ohio River, special arrangements have had to be provided by the Norfolk & Western and the Chesapeake & Ohio Railway Companies to meet stage variations of as much as 70 ft. Similar arrangements are required by the Louisville & Nashville Railway on the Licking River in Kentucky and by the Great Northern Railway on the Columbia River in Washington. Since dependability and avoidance of any service interruption is of primary importance, in some cases the expense for large concrete dry wells has been found warranted, these varying in size and depth up to 30 ft. in diameter and 60 ft. deep. Special intake arrangements are frequently advisable to avoid troubles from sand and trash during periods of heavy runoff. These vary from different type sumps with perforated pipe drift lines to intake towers such as are used by the Chesapeake & Ohio at Russell, Ky., which has suction screens at five-foot levels subject to control from a valve house in order to use water from as near the surface as possible during flood

Water Treatment Station and Concrete Clear Water Reservoir on the Chicago, Rock Island & Pacific R. R., at Shawnee, Okla.

periods. The revolving screen on the suction intake of the Chicago, Rock Island & Pacific plant at Silvis, Ill., has also given good results.

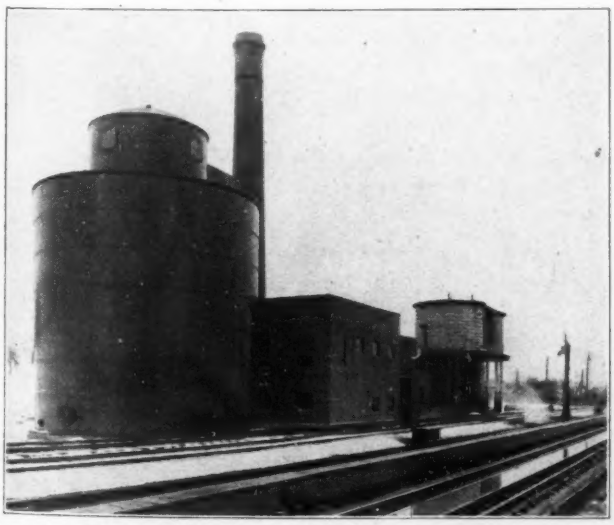
In many cases, long periods of dry weather frequentlly reduce the flow in streams to such an extent that impounding reservoirs are necessary to maintain adequate supply. Such installations are more common in the semi-arid regions of the West, although many are used in the Central States and a few in the East. It is noted that the Canadian National Railway constructed 24 reservoirs during the period 1921 to 1923, varying in capacity from 6,000,000 to 430,000,000 imperial gallons. The Texas & Pacific Railway maintains 22 reservoirs, 17 of which were built in the last few years. These vary in capacity from 21,000,000 to 630,000,000 gallons. A fairly recent installation of interest is the Chicago, Burlington & Quincy Railway reservoir with capacity of 900,000,000 gallons, which was constructed near Galesburg, Ill.

When the annual rainfall is not sufficient to insure an adequate supply from streams or reservoirs it is necessary to resort to wells which vary considerably in size and type, depending upon the locality and accessibility of the water bearing strata. At some points, notably in Louisiana, Alabama, and Georgia, flowing wells have been developed on the Illinois Central and Central of Georgia Lines, with sufficient discharge head to deliver the water direct into the distribution tank. At other points such as on the Atchison, Topeka & Santa Fe System at Gallup, N. Mex., there are wells 2,300 ft. deep with a pumping level 400 ft. below the ground surface. This railroad has many other deep well installations through the desert region, such as those at Danby, Calif., 983 ft. deep, and at Peach Springs, Ariz., 1,003 ft. deep. The Texas & Pacific Railway has many deep well stations as exemplified by those at Van Horn, Tex., where there are four wells 600 ft. deep with working barrels set at 520 ft. below the surface. Railroad wells vary greatly in available capacity and at some points such as on the Missouri Pacific Line at Stuart, Colo., the yield of individual wells is only a few gallons per minute. The operation of small pumps in a series of wells with a jack arrangement similar to that used in pump operation on small oil wells was necessary to maintain a sufficient supply for the locomotives. At other points such as at the Missouri Pacific station at North Little Rock, Ark., gravel wall wells are in service which furnish more than 1,000 gallons per minute each. There are but few dug wells in railroad service at the present time because it has been found that economies can be secured by put-



Pumping Arrangement in 30 Ft. Diameter by 60 Ft. Deep Dry Proviso, Ill.

ting down an improved gravel wall well or else a series of small drilled wells in locations where the yield from water bearing strata is meager. Most of the railroad wells are of the drilled type, especially those deeper than 200 ft., but in gravel or loose formation, wells put down by the rotary process using mud-laden fluid, have met with favor. A good example of this type of construction is the well installed in 1929 at the Columbus, Ohio, terminal of the Chesapeake & Ohio Railway. This well was put down with an outer casing of 56 in. diameter down to the sand strata and an inner casing of 38-inch diameter, the mud-laden process was used and the space between the two casings was filled with washed gravel.



Water Station with Track Pans and Heating Plant on the New York Central R. R.

Tank Facilities

To the casual observer, the most noticeable development in railroad water station facilities during the past 20 years has been in tank construction. It is now rare practice to install a tank of less than 50,000 gallons storage capacity and several have been built lately with capacities in excess of 500,000 gallons. The two most common sizes of wood tanks that are employed are those with staves 16 ft. high and bottom 24 ft. diameter, holding 50,000 gallons, and with staves 20 ft. high and bottom 30 ft. diameter, holding 100,000 gallons, either tank being placed on steel or timber frame of such height

as to permit delivery of water to locomotive tenders by gravity. Standard specifications for such tanks have been recommended by the American Railway Engineering Association, which includes details covering round iron hoops with 8 in. lugs, and also 12 post timber and steel frames. With the increased cost and shortage of suitable tank timber the use of steel has been on the increase. Use of creosoted yellow pine which has been framed before treatment, appears to meet with favor on some railroads, notably the Southern and the Illinois Central. Where larger capacities are required it has been necessary to use concrete or steel. Dependable concrete water tank construction has not as yet reached the point where it can be said to meet with universal favor, although there are a number of installations on the Duluth & Iron Range, the St. Louis & San Francisco, the Norfolk & Western, and the Central of Georgia. The style of steel tank construction appears to vary between the curved bottom elevated and the flat bottom standpipe type, and the choice is governed largely by local conditions.

Sources of Power for Pumping

The choice of power units for railroad pumping stations is a subject which has been given considerable attention. Advantage is being taken of the economies afforded by the heavy oil engine development. Electric power with automatic control has resulted in savings in some instances through reduction of operating labor charges. Steam plants are the oldest and probably still the most numerous but are gradually being replaced. Investigation and report by the Water Service Committee of the American Railway Engineering Association in 1925 indicated that the fuel oil engine was the cheapest power unit to operate for pumping water; electricity with automatic control, next; and steam and electricity with pumpers in attendance, the most expensive. Electric motors are particularly advantageous for direct connection to centrifugal or deep well turbine pumps. In railway water service they will be found to vary from 1.0 to 150 HP. The question of automatic control is a problem in itself for each individual location. The gasoline engines of the early 1900's are being replaced with semi-Diesel and full Diesel engines, which give more economical and dependable service. Sizes of 10, 15 and 25 HP. are most common, although engines are in use up to 180 HP. At many points such units are installed for standby service to protect the water station in case of failure or interruption in electric power supply. The steam power plants will vary from the small size vertical boilers, through the old locomotive type and small return tubular boilers, to the large size stations which are required for pumping the water and heating the track water reservoir pans such as are in service on the Pennsylvania, the New York Central and the Baltimore & Ohia Systems.

Pumping Equipment

The development in railway water service pumps during recent years has been marked. The tendency is to gradually replace the expensive and difficult-to-maintain plunger pump by installation of simple and inexpensive centrifugal types. Based on the estimate that there are 20,000 pumps in railway service and assuming 5 per cent for depreciation and obsolescence, it is indicated that the average annual railway pump replacement will approximate 1,000 units, the greater part of which will be the improved and modern types of pumps. It is not entirely practicable to standardize on a few types and designs because the variation in conditions at the individual locations must be given consideration. Pumping heads will vary from a few feet, through the requirements for fire pressure systems. Probably the maximum pumping head is that found on the Union Pacific where water is pumped from springs in the Grand Canyon of the Colorado River to Bright Angel Point on the rim of the canyon against a static head of 3,870 ft. and a horizontal distance of 2 miles.

Turbine pumps are gradually replacing the old style reciprocating pumps in deep well service and are being used at depths down to 400 ft. Air lifts appear to be favored for the deeper wells and also to obtain larger yield from small diameter holes. Air compressors up to 2,500 cu. ft. capacity are used in this service. One interesting installation reported is on the Atchison, Topeka & Santa Fe at Pica, Ariz., where the air delivery pipe is 1,300 ft. below the surface and 245 lb. starting pressure is required to pump water from 1,788 ft. deep well where the static level is 740 ft.

There are a few water stations in railway service at which the supply is pumped with hydraulic rams, singly or in batteries of two or four. This method affords economical operation where conditions are favorable, but at most points where hydraulic rams can be used, it is also possible to install a gravity line at not much additional cost. Furthermore, the gravity supply will usually give a more dependable supply, particularly during periods of low stream flow.

Advantage has been taken of gravity supplies at a great many locations, particularly in the Eastern and Western mountain country. In some favorable cases the storage tank can be fed by a short direct line while in others, complicated construction details are involved. As the operating costs are usually nothing, such installations can be used to effect economies even when the supply is not available for continuous periods. The longest gravity line in railway service seems to be on the El Paso & Southwestern in the territory between Tucumcari, N. Mex., and El Paso, Tex., where about 180 miles of pipe lines convey clear soft mountain water by gravity from Eagle Creek to Coyote and from Luna to Santa Rosa on the Pecos River. In this installation, it is reported that 137 miles of wood pipe are used, 6 miles of steel, and 36 miles of cast iron, the wood pipe varying from 21 inches to 5 inches in diameter for pressures under 130 lbs. per sq. in., and iron pipe from 15-inch to 12-inch for over 130 lbs. The investment in this water supply was necessarily large, but statement has been made that within two years the reduction in railroad operating costs due to improved water supply was greater than the investment.

Considerable miscellaneous equipment is required to handle the water from its source to point of internal delivery into the locomotive tenders. Waste of time must be eliminated in order to avoid delaying trains and holding up traffic, and at the same time the equipment must function with the greatest possible degree of safety for the operator.

Several railroads have installed pans between the rails and have locomotive tanks equipped with scoops which can be lowered to permit taking water without stopping the train. Such facilities afford economies on high-speed congested districts, but the waste of water, expense of operation and maintenance, as well as the installation cost is so high as to discourage further construction except in unusual cases.

The treatment and improvement of water quality on railroads is a separate study and a general summary of present-day practice will be given in a later article.

EXPERIENCES WITH WATER MAIN CLEANING*

By ARTHUR T. CLARK

Manager Greenwich Water Co., Greenwich, Conn.

IT is not always possible to obtain new or valuable information every time a water main is cleaned, but with each cleaning something of interest is sure to develop —some previous idea confirmed or disproved.

Arthur T. Clark

We probably all have some discouraging operating conditions, but I can look at the picture below (Fig. 1) and be glad that we have had no such condition. This 16 in. main has suffered corrosion to an extent that it is in a very bad condition. It had left a clear opening of but 10¾ ins. in diameter, representing but 34 per cent of the original area, and the carrying capacity was naturally somewhat reduced. Considerably different is the condition of the pipe shown in Fig. 2. As compared with the previous picture, this one shows an ideal condition which, if maintained, would give a maximum carrying capacity and a minimum loss of head. This parcitular pipe is lined with Bitumastic compound to protect the metal against corrosion.

Corrosion and Tuberculation

Tuberculation may appear in many different forms or shapes and may be due to several causes or combinations of them. Reddick and Linderman may be correct in that tuberculation is due to bacterial growths similar to those producing bog ore or limonite. It may depend upon the amount of hardness or the organic matter in the water, or upon the p.H. value. The study of the formation and growth of tubercules is a most important as well as baffling question and its correction through preventive measures or linings will be extremely valuable in future work.

Today's problems, however, force the operator to deal with waters which, in most cases, are not treated to prevent tuberculation, or to cope with mains with little or no linings in which various degrees of tuberculation already exist. The cost of operating under these conditions is considerable, resulting in either excessive pumping costs or in a decreased flow and pressure.

Fig. 1—A Badly Corroded Main in Lawrence, Kan.

It is possible, as has been found in some cases, to so treat the water that tuberculation is retarded and existing tubercules are loosened and sometimes partly removed. This, however, usually results in red water troubles, and the remedy is sometimes worse than the disease. From

*Excerpts from a paper presented before the New England Water Works Association at Springfield, Mass., September 28th, 1932.

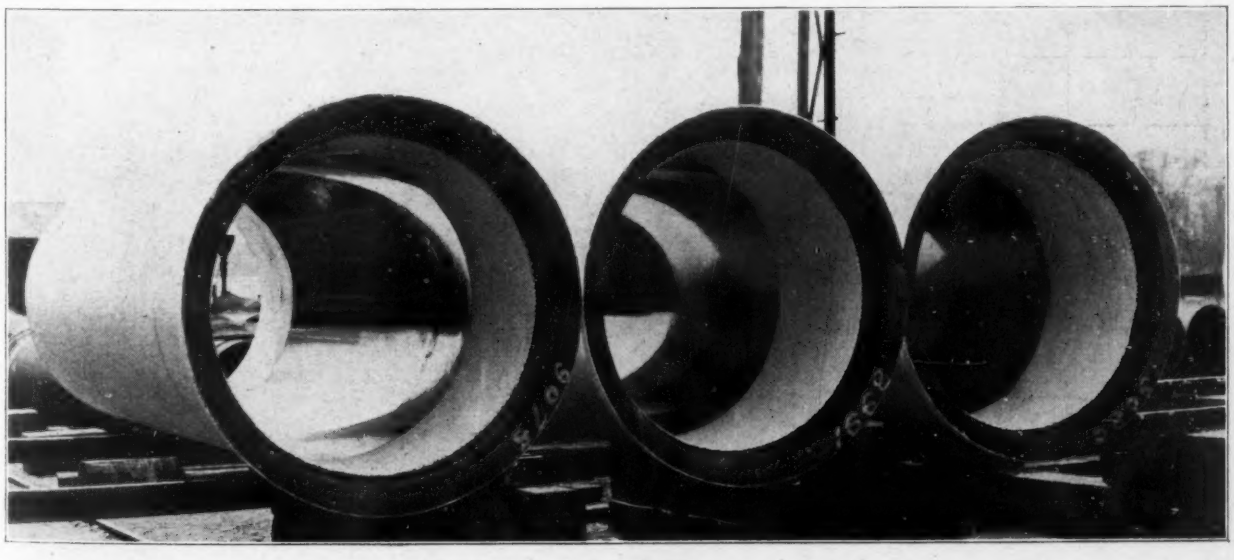


Fig. 2—48 in. Pipe with Bitumastic Lining.

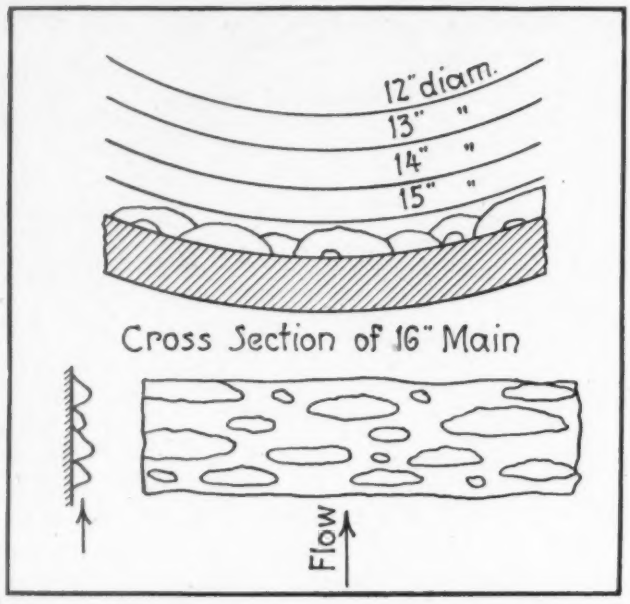


Fig. 3—Sketch Showing Shape, Size and Spacing of Nodules in the Pocantico, N. Y., Main Before Cleaning.

a chemical standpoint, the hydrogen ion value at which calcium carbonate equilibrium exists in water, that is it neither dissolves nor precipitates, may be determined by the so called marble test. At this critical point, which varies for different waters, tuberculation is retarded, or in some cases prevented. The short coming of this treatment is that existing tuberculation is not removed but is hardened. Mechanical cleaning may be resorted to and the main restored to normal capacity quickly, efficiently and reasonably. Cleaning practiced in conjunction with chemical conditioning of the water will hold in check subsequent tuberculation.

Indicative of the loss of carrying capacity which can be caused by a relatively small amount of tuberculation, were the observations made in connection with a 20 inch main at Lexington, Ky. The tubercules though evenly distributed and having depths of but ⅛ to 3/16 of an inch resulted in a lowering of the coefficient to 90.

The sketch (Fig. 3) shows the approximate size and spacing of nodules in the Pocantico main where coefficient of 58.0 was observed before cleaning. It is of interest to note that this tuberculation reduced the flow in this 16 inch main to the equivalent of a 12 inch main having a coefficient of 100.

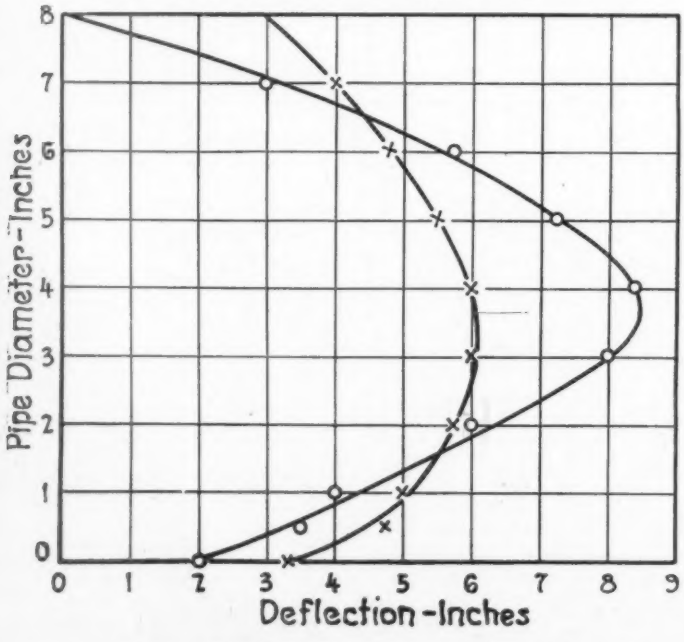


Fig. 4—Comparative Deflection Curves—Taken Before and After Cleaning a Main.

Figure 4 shows a comparison of deflection curves for the same main before and after tuberculation was removed. These tests indicate a pipe coefficient of 0.75 before cleaning and 0.87 after cleaning. (Pipe coefficient equals the mean velocity divided by a center velocity.) It is also interesting to note that the value of C in the Chezy formula was 63.0 before cleaning and 103.5 after cleaning.

Fig. 5 is a photograph (taken from above) of a 24 inch corrugated pipe supplied the author by F. C. Scoby of the U. S. Department of Agriculture. It shows the effect of the corrugations on the smoothness of flow of the water and serves to indicate the turbulence created by protrusions such as tubercules on the walls of smooth pipe.

Fig. 5 — Water Flowing through a 24 in. Corrugated Pipe. Note the Disturbance of Flow Caused by the Ridges of the Corrugations.

Practical Aspects of Cleaning Mains

Where main cleaning is undertaken the following items should be recorded:

1. Periodic records of pressures and flows—based on (a) accurate levels, (b) calibrated gauges or (c) Pitometer or meter measurements.
2. Pipe material and nature of inside protective coating.
3. Age of main.
4. Analysis of water carried.
5. Picture or sketch showing size and spacing of tubercules—such as is shown in Fig. 3.

The cleaning of a water main ordinarily involves excavating, pavement removal and replacement and the opening and closing of the main to be cleaned. In order to defer additional capital expenditure, a seven mile section of a 16 inch main at Pocantico, N. Y., has been cleaned periodically with exceptional results, maintaining maximum capacity with a minimum pumping head. After repeated cleanings for several years, the interior surface of the pipe, and even the coating, remains uninjured. This particular main is located on the Albany Post Road, under a new pavement carrying exceptionally heavy traffic. Under these conditions a method had to be devised whereby pavement cutting and traffic interruptions could be avoided.

A cleaner pit was constructed at the lower end of the section to be cleaned and was designed for a 16 inch main under a 4½ ft. cover. This pit makes it possible to open the main with ease, to discharge the cleaning water directly to an adjoining culvert and to remove the pipe cleaner through a standard manhole in the pavement. (See Fig. 6.) The pit is so designed that a removable section of the pipe can be rolled to one side allowing the necessary cleaning water to discharge into sump and through the outlet drain. The cleaner upon emerging from the main, tends to stand on end in the sump and is easily removed through the manhole.

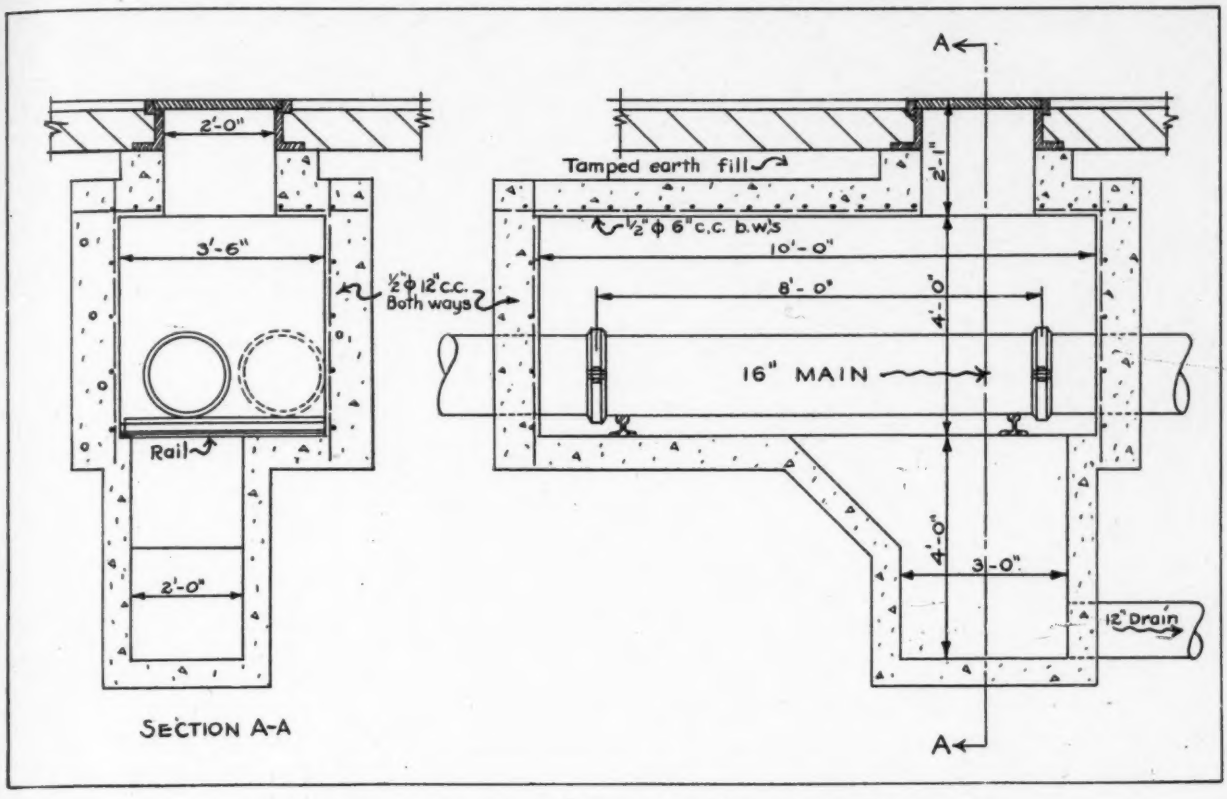


Fig. 6—Design of Pipe Cleaning Pit on 16 in. Main at Dobbs Ferry, N. Y.

Figure 7 shows the method of preparing a standard 12 foot length of bell-and-spigot pipe with standard Victaulic couplings which was used in the pit on our Pocantico main.

For the insertion of the cleaning machine "Y" branches have been used successfully at the head of the section cleaned.

Expense of Cleaning

It has often been said that cleaning is expensive—and it is, but in most cases it is not nearly as expensive as the operating cost would be, if cleaning were not resorted to. The saving in pumping cost alone at the Pocantico plant amounted to roughly $4,800 per year, to say nothing of the value of the increase in the capacity of the main or of the saving through deferred capital expenditure for additional main capacity.

There is another possible item of expense incident to cleaning, and that is the length of time that the main is out of service. This can be kept to a minimum through proper and experienced supervision. The possibility of the loss of the cleaning machine resulting in a seemingly futile search is discouraging and expensive, but this can be avoided and long lines can be cleaned safely and with speed. Proper supervision and improved technique with modern equipment will prevent these costly delays and excavation incidental to the search for a lost machine. Such delays are not only costly but are dangerous. In fact, the length of the shut-off, or the time that the main is out of service depends almost entirely upon the reliability of the operator and the equipment, combined with the best possible cooperation of the local department.

With the arrangements provided at Pocantico, the seven miles of 16 inch main can be cleaned in three hours and the total time that the main is out of service, including tests of the coefficient, averages about five hours.

Results

The main between Pocantico and Dobb's Ferry, N. Y., is cleaned now every six months. Figure 8 shows the hydraulic gradient along the 7 mile section, for different

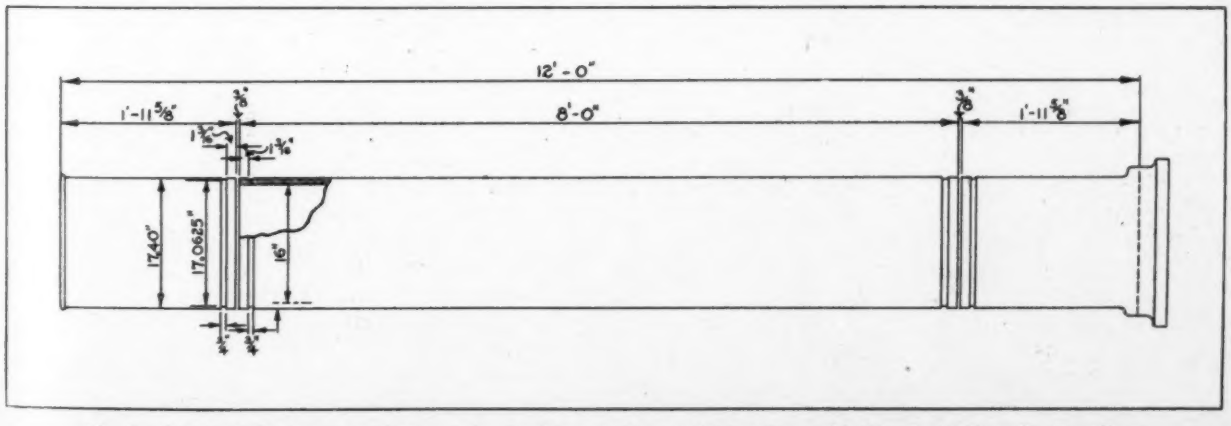


Fig. 7—Method of Preparing Removable Section of Pipe Held in Place with Standard Victaulic Couplings.

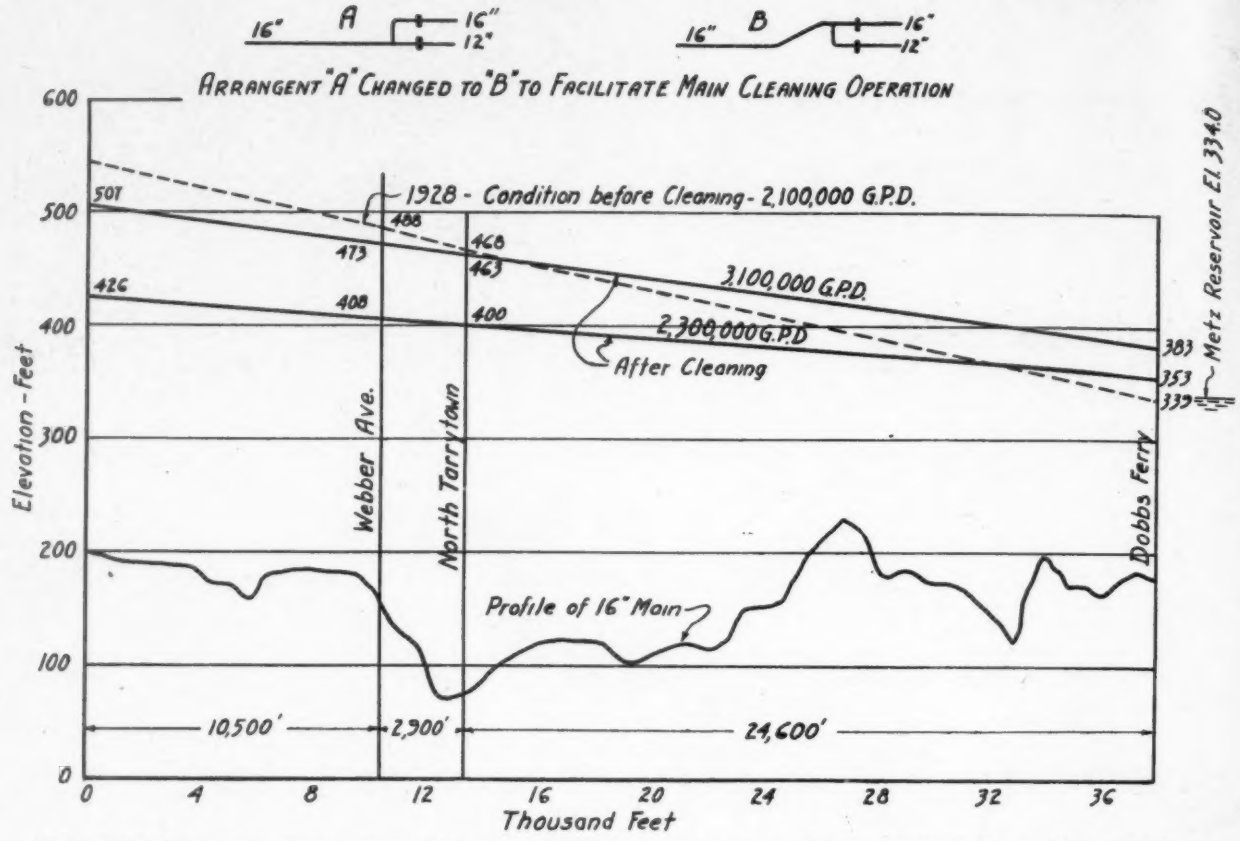


Fig. 8—Profile and Hydraulic Grade Line of 16 in. Main (Dotted Lines Before and Solid Lines After Cleaning).

flows, before and since cleaning operation were undertaken periodically. The increased carrying capacity, together with the reduced pumping heads, is indicated. The net saving of roughly $4,800 per year is our reward.

Practical Sewage Treatment Provided at New York State's Institutions

An interesting description of unusual sewage treatment plants installed to purify the sewage from New York State institutions has recently appeared in "Health News" by the State Department of Health. During the past year new treatment plants have been constructed and old ones reconstructed at a number of such institutions. This has come about as the result of an investigation made in 1929 by the State Department of Health for Governor Roosevelt's special committee appointed to study stream pollution by state institutions. The more serious cases reported have been corrected and gradually sewage treatment will be practiced at every such institution.

Some of the Recent Installations with Unusual Features

The new treatment works for the Great Meadow Prison at Comstock was put into operation in July. It consists of bar screens and Imhoff tanks, scum digestion tanks, trickling filters and sludge drying beds. These units are entirely covered by two large glass enclosures of typical greenhouse construction. This plant is unusual in that provision is made for dosing the sewage onto the trickling filters, which are circular in shape, by means of rotating distributors. The only other installation of this kind in New York State is at the state reformatory at Napanoch. A very high degree of efficiency is being obtained at the Comstock works although it has been in operation only a short time. This plant was designed for disposal of sewage from a population of 2,000, and cost about $66,000.

The state institution buildings at Dannemora are also served by new sewage treatment works which were put into operation recently. This plant, consisting of an Imhoff tank and sludge drying beds, is enclosed by a glass structure. This installation, designed to meet the sewage disposal needs of a population of 3,000, cost about $38,000.

Many modern features of sewage treatment, such as mechanically cleaned bar screens, mechanical scum and sludge removal equipment in the settling tanks, and mechanical scum breakers in the sludge digestion tanks, are included in the plant at the Hudson River State Hospital at Poughkeepsie. The settling tanks and sludge drying beds are in glass enclosures.

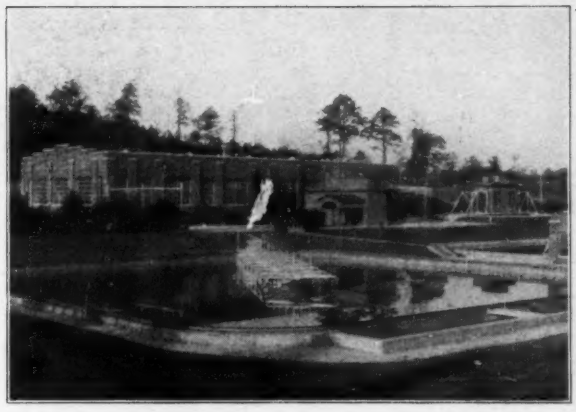
The sewage is chlorinated as it enters the plant for odor control and again before its final discharge into the Hudson River.

A new plant, consisting of Imhoff tanks, trickling filters and sludge beds has been constructed at the state reformatory at Napanoch to replace an obsolete and inadequate system of tanks and sand filters. As indicated above, the sewage is dosed onto trickling filters by means of a new type of rotating distributor. These works cost approximately $50,000 and were designed to serve a population of 2,000.

The State assisted in financing the cost of rebuilding a sewage treatment works in the village of Newark, where the sewers of the state school are connected with the municipal system. The plant has been completely remodeled and enlarged during the past year.

Sewage treatment works, consisting of Imhoff tanks and glass-covered sludge drying beds have also been constructed during the year at the Matteawan State Hospital at Beacon. The population for which these works were designed is 3,000, and the cost was about $37,000.

Winston - Salem's Sewage Treatment Plant.



MEETING OF NORTH CAROLINA WATER WORKS SEWAGE WORKS ASSOCIATIONS

THE City of Winston-Salem, N. C., was host to the North Carolina Section of the American Water Works Association and the North Carolina Sewage Works Association, holding a joint meeting at the Robert E. Lee Hotel on October 31 and November 1 and 2. Members and guests in attendance, numbering approximately 275, enjoyed a particularly fine program of technical papers arranged by Secretary H. G. Baity, Dean of Engineering, University of North Carolina. The entertainment and the inspection trips to the Winston-Salem plants and points of interest in the city were arranged and directed by Captain H. L. Shaner, Commissioner of Public Works, and W. E. Thrasher, Engineer in Charge of Water Works and Sewerage, both richly deserving the vote of appreciation tendered them and their assistants by the two associations.

Wm. C. Olsen, Consulting Engineer, Raleigh, N. C., President of the Association.

J. H. Bridgers, Manager Water Department, Henderson, N. C., President-Elect.

The annual banquet was presided over by Colonel Wm. A. Blair, an old resident of Winston-Salem, who seemed to know considerable about the water supply of the city and this knowledge coupled with a steady flow of ready wit and humor placed him well toward the top of the list of toastmasters that this writer has met.

Having disposed of the serious business dealing with "The Unemployment Relief Program," reviewed by Dr. F. W. Morrison, State Director of Relief, and the discussion of the now almost threadbare topic, "R. F. C. Loans for Self-Liquidating Public Works," by Colonel J. W. Harrelson, Chairman of the North Carolina Committee on Trade Recovery, entertainment in the way of dancing and singing by young ladies of Winston-Salem was followed by dancing by all. This evening of entertainment was in addition to the enjoyable dance given by the city on the evening previous.

In speaking briefly at the banquet, Beekman Little, Secretary of the American Water Works Association, extended a rare compliment to the North Carolinians when he said that the North Carolina Section had early in its existence set an example for all other sectional groups in the parent association and that he would be pleased to report that North Carolina continues to "carry on." He spoke of the extensive arrangements under way to make the Chicago (World's Fair) Convention of the A. W. W. A. the best ever held and that he hoped to see North Carolina strongly represented there.

R. D. Beam of Raleigh was announced as the winner of the Maffit Membership Cup for the third time. In presenting the cup, M'Kean Maffit, its donor, stated that the third and last leg in the cup had been won by Mr. Beam and thereby it had passed permanently into his possession as a deserving winner—he having for three years been successful in bringing in more new members than anyone in the association.

Officers elected for the ensuing year were: President, J. H. Bridgers, Manager Water Department, Henderson, N. C.; Vice-President, L. I. Lassiter, Department of Health of Wilmington, N. C.; Secretary and Treasurer, H. G. Baity, University of North Carolina, Chapel Hill, N. C.; Editor, Earle G. McConnell of Charlotte, N. C. Mr. McConnell and W. M. Platt of Durham, N. C., were named as representatives on the Board of Control of the Federation of Sewage Works Associa-

Convention of the North Carolina Section of the American Water Works Association and the North Carolina Sewage Works Association, at Winston-Salem, Nov. 1, 1932

tions. Statesville, N. C., was chosen as the meeting place for 1933.

Technical Sessions

(President Wm. C. Olsen of Raleigh, N. C., Presiding)

Following the address of welcome by Hon. Geo. W. Coan, Jr., Mayor of Winston-Salem, and response by President Olsen, the following papers were presented:

"The Water Supply and Sewage Disposal Facilities of Winston-Salem" were described by W. E. Thrasher, Engineer in Charge of Water Works and Sewerage at Winston-Salem.

Mr. Thrasher dwelt on the design features of the water works which had taken into consideration every practical safeguard against emergencies. Such features included the one billion gallon gravity storage of raw water, two gravity mains to the filtration plant, ample pumping equipment plus duplicate auxiliary gasoline engine driven standby units, duplicate clear water storage

W. E. Thrasher, Engineer in Charge of Water Works and Sewerage, Winston-Salem, N. C.

Captain Harry L. Shaner, Commissioner Public Works, Winston-Salem, N. C.

basins and five separate pressure mains to various points in the city. The water works system represented an investment valued at $3,600,000, included 288 miles of mains and 1,800 fire hydrants. A new filtration plant completed in 1925 employed air blowing for rapid primary mixing followed by slower mechanical coagulation. Rate control to automatically speed up and slow down all filter units simultaneously with changes in clear water basin elevations and a most successful slow operating master wash-waetr valve of special design constituted the unusual appurtenances with which the plant had been equipped. Prechlorination had come to be routine practice. High pressure nozzle aeration followed by pH adjustment with lime and post chlorination represented treatment given the filtered water.

In connection with the sewerage system, Mr. Thrasher reported that R. F. C. aid in extending sewers had been applied for. The sewage treatment works, the only one of its kind operating, made use of chemical-mechanical processes, was odorless and gave little or no trouble. The process originally known as the direct oxidation process, embraced pre-screening, grit removal, heavy lime application to maintain caustic alkalinity of 50 parts per million and passage through electrolyzers. The lime precipitated matter settled out in clarifiers having 1 hour detention or thereabouts, the effluent being discharged to a small creek. The sludge, after thickening in a small tank, was additionally limed and dewatered to a non-odorous cake (76 per cent water) on vacuum filters. No nuisance resulted from sludge cake piled around the plant, eventually to be hauled away by farmers and others. Mr. Thrasher made reference to the Municipal Repair Shops, Salvage Yard and Garage which had been established in the Department of Public Works. It had proved of tremendous convenience and had effected savings of city funds far in excess of those anticipated.

Following Mr. Thrasher's paper the members visited the sewage pumping stations, the treatment works, the garbage and rubbish incinerator and the water works pumping station and filtration plant, all of which bore evidence of high class management and efficient operation.

Symposium on Administration of Water and Sewer Departments

"Office Practice in the Winston-Salem Water and Sewer Department" presented by R. L. Dixon, Chief Accountant of the Department of Public Works, covered in detail the new machine system employed for record keeping, billings and collections. A new card billing system saves $2,400 per year in postage, one man being required for three days each month to get out bills covering 13,200 accounts. Sewer rental (10 per cent of the water charge) charges appear each month on the water bills.

"Metering," as discussed by D. M. Williams, Assistant Superintendent of Water Works, Durham, N. C., stressed the need for adequate records of measurement of water at various points on the water works system. Stream flow records in conjunction with impounded supplies an evaporation records seemed to be of considerable value. Meters at the inlet and outlet end of filtration plants had been valuable in showing the water losses through the plant. The distribution system should be 100 per cent metered as had been the case at Durham since 1928 where 3,369 meters now existed—the annual receipts for water being $30,000. Meter reading was done by a two man crew—a laborer and the meter reader who does the paper work. The crew reads 350 to 400 meters per day.

Mr. Williams' paper started a lively discussion concerning wasted water and "free" water to municipal departments, schools, for street flushing, etc., and culminated in a spirited speech by M'Kean Maffitt, Superintendent of Water Works at Wilmington, N. C., which to this writer's mind was the high-light of the convention. Mr. Maffiitt's philosophical speech might be titled *"Why Should the Water Department Remain the Political Football That It Has Come to Be?"* It was a straight-from-the-shoulder talk, expressing the sentiment of many a brother superintendent. He said that "free" water to public buildings, hospitals and municipal departments usually meant wasted water. To curtail such waste, frequent inspections by the water works personnel would be required. Operating flush tanks on sewers, street flushing practice and the like consumed water for which the Water Department receives no credit. On the other hand, his experience had been that whatever was supplied in the way of mechanical service or materials to the Water Department by other municipal departments was charged against the former. Water Departments had all too commonly been expected to do repair work for others in its shops without charge. Why should such practice be allowed to continue? He had been fighting these practices ever since assuming the duties of superintendent but had come to feel that the situation would not improve materially as long as the Water

Department continued under political influence. He thought perhaps that water works officials lacked the ability of adequately informing municipal governing bodies and city officials concerning the operation of the Water Works and hidden expenses created by free water and service to other departments and were, thereby, at fault. More "intestinal fortitude" would have to be displayed by water works officials, declared Mr. Maffitt, if they were to demand the consideration deserved and fair returns for service rendered by the Water Department. It would be a case of more fight

Warren H. Booker, Chief Engineer, State Board of Health, Raleigh, N. C.

D. S. Abell, Assistant Engineer, State Board of Health, Raleigh, N. C.

and less complaints that would bring about the desired results.

In further discussion Mr. Thrasher said, that sewer flush tanks at Winston-Salem had consumed two million gallons of water per day until they had substituted a flushing crew of two men with a truck. All water supplied public buildings was metered and collected for by the Water Department, actually receiving $10,000 per year for such water. At Greensboro all water used by the city except that for fires and street flushing was being metered. At Durham all water pumped is accounted for, including street flushing.

As to the matter of removing Water Departments from political influence, it was pointed out by *J. S. Whitener* that there was need for legislation in North Carolina which would establish separate water commissions which would retain water revenues in the Department for needed betterments rather than leave them in the status of a sort of plum-pudding for Jack Horner politicians to stick thumbs into.

C. W. Smedberg of Greensboro and *H. L. Shaner* of Winston-Salem were of the opinion that separate commissions to operate water works were not needed and that it became a matter to be solved by management and personnel rather than through a separation of departments.

"Water for Fire Service" was the topic dealt with by M'Kean Maffitt, Superintendent of Water Works at Wilmington, N. C. Mr. Maffitt illustrated his talk with diagrams which revealed conditions to be met in producing fire streams and means of best meeting the requirements. The wisdom of providing numerous hydrants, with at least two on each corner in business districts, and the use of short hose lines was evident from the analysis of the problem which disclosed a loss of pressure at the nozzle amounting to 15 lbs. for every 100 feet of hose when a 250 gallon per minute flow was passing through or 36 lbs. per 100 feet if as much as 350 gallons per minute was being forced through. In touching on the importance of main sizes, he said that with a residual main pressure of 70 lbs. per square inch 1,000 feet of 6 inch main would provide 2 fire streams totalling 500 gallons per minute and a 12 inch main would provide 1,700 gallons per minute or about twice that of the 8 inch main and four times that of the 6 inch main.

"Rate Making" was discussed by J. H. Bridgers, Manager of Water Department, Henderson, N. C. Mr. Bridgers said that the basic principle of the present day disc type meter was of German origin. In making rates for water supplied by municipally operated works it was permissible to use nothing more than the actual operating costs plus amortization of funded debt. That, divided by the number of services, would disclose the minimum charge to each. Thereafter, a sliding scale of charges for large consumers should be evolved. Inasmuch as water departments were depending on meters to equitably apportion the costs to consumers it was essential that these instruments be maintained properly and checked for accuracy.

"Progress in Water Purification and Sewage Treatment on the Pacific Coast" was presented by Harry N. Jenks, professor of sanitary engineering, University of North Carolina. Professor Jenks, who had been practicing engineering on the Pacific coast prior to taking his present position at the University of North Carolina, gave a resume of the progress being made in water works and sewerage on the West coast. He said that in the Northwest particularly, industrial plants demanding high grade water had been leading the way in water supply improvements. Everett, Wash., for example, had recently completed a 50 m.g.d. project to provide water for paper mills. The scheme of chlorination there entailed the use of a tower filled with crushed limestone through which the chlorine water passes to convert chlor-

McKean Moffitt, Superintendent of Water Works, Wilmington, N. C.

R. D. Beam, Engineer, Raleigh, N. C., New Membership Cup Winner.

ine to hypochlorous acid enroute to the point of application. The water of the Northwest was plentiful, very soft but frequently highly colored. California was not so blessed, either in quantity or quality of waters. The Southern California Metropolitan District, composed of 13 cities, were planning to utilize Colorado River water which contained on the average 350 parts of soap hardness and a tremendous turbidity difficult to remove. Pumping would entail a total lift of 1,100 feet at a cost of $90 per million.

The Sacramento filtration plant now being increased

from 32 m.g.d. capacity to 64 m.g.d. was the earliest to make use of mechanical coagulating tanks and the floating cone aerator nozzles of special design requiring but 3 feet of head to function. Water softening was being practiced at Beverly Hills, Calif.

Sewage treatment had been slow of development in the Northwest because of large rivers providing the necessary dilution. Industrial wastes, particularly sulphite paper mill wastes, had been more of a problem. In California matters were different and lack of streams necessitated high degree sewerage treatment by 62 municipalities with partial treatment at 86 additional places. Professor Jenks mentioned some of the more important developments and the income procurable from the sale of sludge and effluent for irrigation or industrial use. The use of activated sludge effluent in locomotives at the Grand Canyon had proved satisfactory. Experimental studies in sewage treatment indicated a trend toward reclamation of the water through extended use of sewage effluents for industrial purposes and irrigation.

Symposium on Purification Plant Operation

"Methods of Obtaining Technical Control of Purification Works," by D. S. Abell, Assistant Engineer, State Department of Health, Raleigh, N. C.

Mr. Abell, formerly Assistant Engineer of the Ohio State Department of Health, called attention to the increasing opportunities available to water works operators wherein they could increase their knowledge of plant control. Water Works Short Schools, conducted in a number of states, have proven particularly valuable to operators and superintendents wishing to better themselves. Licensing of water works operators was rapidly gaining favor and was resulting in a better class of men in charge of plants and systems. He advocated the "group plan" of high grade plant supervision, wherein one proficient man would be able to serve several municipalities within a reasonable distance of each other. Through such an arrangement the cost of technical supervision would be slight to each city or town. The plan had worked well in numerous instances and was favored by State Health Departments as is the scheme of having the Consulting Engineer supervise operations of new plants during the first year at least.

"Opportunities for Research in the Operation of Water Purification Plants" was the topic dealt with by M. F. Trice, Principal Assistant Engineer, State Department of Health, Raleigh, N. C. He said that the text on which his talk was based was "Know Your Plant" and that successful operators and superintendents were those possessing an inquisitive disposition, inventive ability and initiative. With such attributes much could be learned and done to improve plant performance. He enumerated examples of what had been accomplished at several North Carolina plants as the result of efforts of operators to improve conditions. Successful removal of manganese, iron and organic matter had been an important and rather widespread problem recently. Sand bed troubles could usually be traced to imperfect chemical preparation of the raw water and much could be learned in that direction. Periodic superchlorination of the filter beds had proven very helpful in maintaining cleaner filters. In some instances, caustic soda treatment had been effectively used for the same purpose. Wash water rates of 1 inch vertical rise per inch of freeboard between (sand level to top of wash water troughs) which had been considered standard practice, did not prove satisfactory in all cases. More study of this feature was needed. In manganese removal, oxidation could be effected by prechlorination and precipitation by lime added to raise the pH value to 9.2 or better. Iron removal was simpler and aeration or prechlorination would serve to oxidize the iron which would precipitate out at lower pH values than would manganese.

Paul W. Frisk of Enka, N. C., said that his experience has shown that filters cleaned with caustic soda had not been as efficient in removing manganese as previously. He was now starting a study of filter media with the idea of selecting the most suitable material for their requirements at Enka where the problem was complete manganese, iron and color removal from an impounded water used in producing high grade Rayon.

A. M. Worth of Durham, N. C., said that their experience with caustic soda had been the same as that at Enka but that cleaning the sand beds by heavy chlorination had not caused the filters to pass manganese.

L. H. Enslow referred to the very successful use of periodic super chlorination to clean the sand beds at the Atlanta, Ga., plant and likewise at other plants—the Beverly Hills, Calif., plant being perhaps the first to utilize the scheme. The procedure developed by Mr. Paul Weir, Superintendent of Filtration at Atlanta entailed the use of a large alundum diffuser attached to the end of a rubber hose through which chlorine gas was admitted from a cylinder of liquid chlorine. The diffuser being submerged in the deep influent bay across the front of the filter, chlorine was fed to the diffuser at as rapid rate as could be applied and yet avoid any appreciable escape of undissolved chlorine gas bubbles at the water surface. This operation was continued during the slow filling of the drained filter until the sand had been entirely submerged. In this manner the filling water would be high in chlorine content and attack the films on each sand grain during the period that the unit could be held out of service—up to 24 hours if possible. Following the chlorination the unit was heavily washed and returned to service. Such treatment was given filters in rotation—one unit per day—and if there were 10 units the treatment could be given each unit every tenth day if necessary without disturbing plant operation. The procedure at Atlanta had resulted in keeping the sand exceptionally clean.

Professor H. N. Jenks reported that the use of ferric chloride or chlorinated copperas as the coagulant on the Pacific coast had alleviated sand bed troubles and wished to suggest the use of ferric iron coagulants as a possible expedient in the East.

It was developed that chlorinated-copperas, first applied at Elizabeth City, N. C., continued in successful use there and recently Providence, R. I., had also adopted it with success.

"Improved Coagulation at Richmond, Va.," was the subject of a paper by M. C. Smith, Engineer in Charge of Water Purification at Richmond, Va., in which the author recounted a noteworthy advance in coagulation practice that had effected a remarkable reduction in coagulant costs at Richmond during the past year. Mechanical devices, conceived and designed by Mr. Smith, which in brief are similar to the paddle wheels on a stern-wheeler river boat had been installed across the inlet end of the coagulating basins. The existing baffled mixing chamber serving as the rapid mixing device, had been supplemented by a battery of the two bladed paddle wheels which served to cause agglomeration of fine particles into floccular and rapidly settling masses —hence the coined name "Flocculators" had been given these devices. Rotating against the direction of water flow the paddle blades had created a counter current

along the bottom of the basin and thereby continuously returned heavy floccular particles to the incoming water and thus served as "sludge return" devices to an extent which had proved of added value. The cost of operation of the "Flocculators" had been negligible each battery being driven by a 3 HP. motor consuming 2.4 K.W.H. per hour or 2.5 cents per hour for power required at Richmond where 26 M.G.D. had been the average plant output. The first cost of the "flocculators" was actually about one-fourth the estimated cost of baffled head consuming chambers to provide the same period of mixing.

The value of the "flocculator" had been established during the first 11 months of operation in which wash water had been reduced by 50 per cent—it having averaged only 0.59 per cent in 1932. Alum had been reduced between 700 to 1,400 pounds per day resulting in a saving of $23,000, amounting to $5,000 more than the cost of the installation. Water analyses had shown a more effective removal of organic matter and residual alumina and the greater brilliancy of the settled coagulated water entering the filters was marked. The money saved had paid all operating expenses of the plant, other than power and chemicals.

Mr. Smith was highly complimented by members for having shown the inventive ability and initiative referred to in Mr. Trice's paper as constituting such important qualifications of successful water works operators. The results obtained had confirmed Mr. Trice's remarks concerning the value of properly conditioning the raw water.

Effect of the Depression on Water Works Operation

The Association's Committee on Water Works Statistics presented its report based on a survey which had been made to determine to what extent the depression had deleteriously effected water works finances, improvements, and operation. Mr. Warren H. Booker, Chief Engineer of the State Department of Health, in discussing the report called attention to the fact that extension and replacement of water mains had dropped from 20 miles in 1928 to 2 miles in 1932. New connections had dropped also. Surprisingly little, however, had water sold fallen off, the per capita consumption having dropped to only 72 gals. in 1932 as compared with 85 gals. in 1928. The total drop in consumption had amounted to not more than 10 per cent during the depression years. Revenues from the sale of water had fallen remarkably little but in the face of such sustained earnings water works operators salaries had been cut out of all proportion. In every North Carolina city surveyed there had been one to three reductions which in most instances had amounted to a 20 per cent cut.

Only one city—Roanoke Rapids—is to definitely receive R. F. C. aid but three others are applying for it. Eleven cities had allowed consumers in arrears to work out a part if not all of the debit.

Mr. Booker said that he thought that cuts in water works salaries had been overly severe when considering the small falling off in income to the city from the water department and hoped that the report of this committee would prove useful in securing early reinstatement of 1930 salaries.

Papers Dealing with Sewage Works Operation

Lack of space in this issue will necessitate the printing of digest of papers dealing with sewerage and sewage treatment and discussor's comments in the next issue of Water Works and Sewerage. The following papers were presented:

"Sewage Works Financing," by C. W. Smedberg, Director of Public Works, Greensboro, N. C.

"Operating Results at the Dearborn, Mich., Mechanical-Chemical Sewage Treatment Plant," by Mark B. Owen, Superintendent Public Works, Dearborn, Mich.

"The Effects of Sewage Chlorination on the Receiving Stream," by H. G. Baity, Dean of Engineering, University of North Carolina, Chapel Hill, N. C.

"The Effect of Sulphite Paper Mill Wastes on Sewage Sludge Digestion," by M. S. Campbell, Research Fellow, The Textile Foundation, Chapel Hill, N. C.

"The First Year of Sewage Treatment Plant Operation Is the Hardest," by A. R. Hollett, Superintendent of Sewerage, Chapel Hill, N. C.

The Action of Bacteria in the Tuberculation of Water Mains

Having read the interesting and suggestive article on "Tuberculation of Mains as Affected by Bacteria"* by H. G. Reddick and S. E. Linderman of the U. S. Pipe and Foundry Co., two English writers, Messrs. F. W. Hammond and Arthur Gaffey, were prompted to contribute their experiences and observations of the same phenomena in "Water and Water Engineering" from which the following is quoted:

"Soft acid waters from moorland and upland gathering grounds, which supply the majority of the English industrial areas, give rise almost invariably to tuberculation, and iron bacteria are always associated with them as the cause of these encrustations. Furthermore, tuberculation associated with bacterial action has been observed by us with waters of alkaline character, and quite notable encrustations have been formed from ferruginous waters of *p*H value 7.6 and 7.8, iron bacteria being present in these cases.

The activities of these bacteria cannot be definitely said to cease when the appropriate iron content and organic matter are present, before the high alkalinity represented by a *p*H value of 8.4 and 8.6 is reached.

Our experience is that certain of these iron bacteria have an optimum *p*H value of the water in which they exhibit maximum activity.

Type of bacteria.	Optimum *p*H value.
Crenothrix.....	5.8/6.4 Acid.
Gallionella.....	6.4 6.8 "
Cladothrix.....	7.0/7.2 Alkaline.

Leptothrix and spirophylla are more catholic in their demands and are common from *p*H 5.8 to 7.8.

It is generally agreed that iron bacteria can exist in the absence of iron, given suitable organic material to support their existence, but in most of these moorland waters the water contains organic acids derived from the decomposition of peat and other cellulose materials, which acids form a soluble ferrous salt, with iron present in the underlying sand and strata.

Many authorities are of the belief that the bacteria take up the organic radicle of the salt, precipitating the iron as ferric hydroxide, either about or within their structures.

It is universally found here that for the growth of definite turbercles of ferric hydroxide the presence of exposed iron is essential, the smallest pin-hole in the protective coating being sufficient to provide a nucleus. Nothing more drastic than long streamers, or a slime, are found on inert surfaces, such as wood, when exposed to the flow of these waters, but these slimes and streamers are very definitely of bacterial origin.

*See WATER WORKS AND SEWERAGE—October 1931, page 293.

Sky-Line Drive, New Scenic Highway between Washington and Staunton, Va.

MEETING OF THE VIRGINIA WATER & SEWAGE WORKS ASSOCIATION

THE Fourth Annual Conference of the Virginia Water and Sewage Works Association was held at the Hotel Stonewall Jackson in Staunton, Virginia, on November 14th and 15th. The registration (ladies not counted) was 112.

A feature of the meeting was the banquet given by the City of Staunton following the special review and silent drill staged by the Cadet Corps of the Staunton Military Academy which was quite impressive with the sun setting behind the azure mountains forming the western boundary of the Valley of the Shenandoah. At the banquet, C. K. Brown, a member of the City Council and newspaper man, presided as master of ceremonies, and a good one. By way of starting things, he said that he hadn't met many of the members of the association but he wanted them to know that "in any gang that started singing 'Sweet Adeline' during the second course —he was one of the bunch."

The Mayor of Staunton, Hon. Geo. A. Cottrell, delivered a brief address of welcome to which Mr. Willard Day, City Manager of Staunton and President of the Association, responded. Dr. Warren F. Draper, State Health Commissioner, addressed the association on the subject of old and new beliefs concerning disease and health, and advances in measures of health protection.

W. E. Day, City Manager of Staunton, Va., and President of the Association.

An extremely interesting informal address was delivered by Dr. Herman Finer, Professor of Public Administration, at the University of London, England. After discussing the present trend of developments in public service in foreign countries and in America, he said that he believed that the future will see higher calibre of men in public service and government. He had observed that the top ten per cent of college men were entering the public service each year and that was an indication of what might be expected in the future. He intimated that "job holders" would have to give way to professionally trained men and that there would be a changed atmosphere in the City Halls as time advanced. The change, he said, had progressed further possibly in England than in America.

Business Meetings

A movement of importance was started by the appointment of a committee headed by E. F. Dugger, general manager of the Newport News Water Works Commission to study existing rules and regulations of various water departments now in force with the idea that a "Standard Set of Rules and Regulations" to procure uniform practices might be drawn for use, in part if not as a whole, by the several Virginia municipalities and privately owned water works.

Changes in the by-laws of the association to bring them into closer conformity with those of the American Water Works Association were voted on and accepted by the association. The change in meeting date from November to June was proposed and accepted. The place selected for the June, 1933, meeting was Newport News, Va.—it being whispered before the voting that free beer was promised by that time. We understand, however, that Mr. Dugger, the newly elected president of the association, would not guarantee that feature of the next meeting.

E. F. Dugger, Manager Water Works, Newport News, Va., President-elect.

Henceforth proceedings of the association will be printed or otherwise prepared for distribution and a publication committee has been named headed by M. C. Smith of Richmond as chairman.

New officers elected for the ensuing year consist of the following:

President, E. F. Dugger, manager of Water Works, Newport News, Va.

Vice-President, B. S. Parrish, superintendent Department of Public Works, Martinsville, Va.

Secretary, H. W. Snidow, State Department of Health, Richmond, Va.

Treasurer, C. F. Bingham, assistant superintendent Filtration, Richmond, Va.

Members of the Executive Committee, W. F. Day, City Manager of Staunton, Va., and D. R. Taylor, superintendent of Water Works, of Roanoke Va.

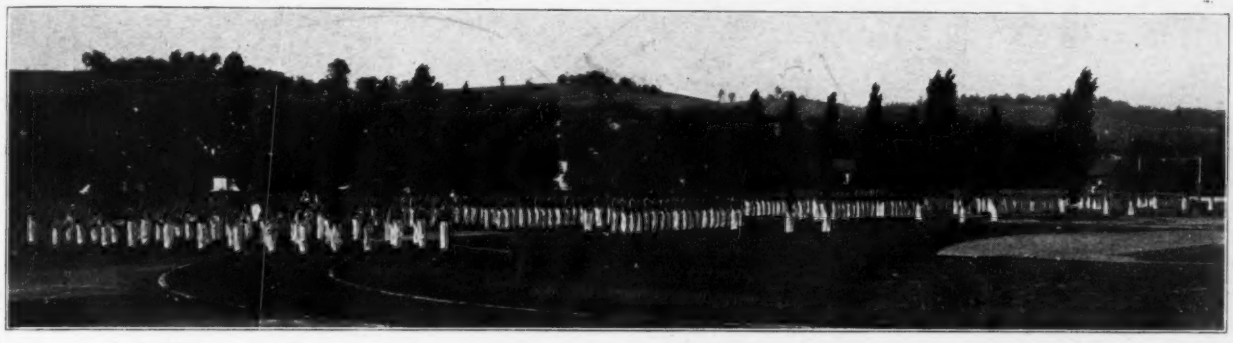
Technical Sessions

(W. F. Day, Presiding)

"Staunton's Water Supply," by R. R. Catlett, Chemical Engineer, Staunton, Va.

Mr. Catlett covered the history and incidents of importance from the conception of the earliest public water supply system installed in Staunton in 1853, which had supplied a hard water, to the $814,000 project of 1926

which had brought in all gravity supply of soft mountain water from an impounded supply of 125 million gallons through 15 miles of 20 and 16 inch cast iron pipe line. The quality of the early supply had caused incrustation and house service stoppage whereas the new supply, before starting lime addition to reduce corrosion, had removed all of the limestone from the pipes—and, he added, much of the household plumbing in addition. Copper services were being exclusively used and lime added after aeration at the dam raised the hardness from the 10 parts naturally present to 25 parts. A pH value of 10 at the dam and 9.6 in the city had been required to effectively subdue corrosion. The supply received double chlorination—once at the dam and again at the service reservoir on the outskirts of the town. Of the present flow of 1.25 m.g.d. entering the distribution system only 65 per cent could be accounted for, even though Venturi meters were in use at each end of the 15 mile line and distribution was 100 per cent metered—including public buildings. Leakage on the system was without doubt entering limestone caverns underlying the city, thereby escaping detection. The system, not withstanding, had been operating at a profit of $16,000 per year.



Cadets of Staunton Military Academy on Dress Parade and Exhibition Drill Given in Honor of the Virginia Water and Sewage Works Association

The Effect of Hardness and Dissolved Oxygen on Corrosion Correction

In the discussion of Mr. Catlett's paper the question was raised as to why it had been necessary to produce a pH value as high as 10 at the dam to stop corrosion. W. F. Day explained that they had tried lower lime dosages but had not been rewarded with success until a pH of 9.6 was maintained in the distribution system. They had tried various lime dosages while observing a test installation of several different pipe materials and the observations made indicated that at a pH value of 9.4 to 9.6 corrosion could be checked. Since going to the indicated lime dosage the red water troubles had practically ceased.

In further discussion, L. H. Enslow called attention to the fact, that if Staunton's water had contained more hardness than 10 parts the pH value would not have had to be carried so high. In cases where the temporary hardness was low and dissolved oxygen was present it seemed necessary to approach caustic alkalinity to stop corrosion—that held even in cold water lines. In boilers a pH of 10.5 or more would be required as a rule. The presence of dissolved oxygen had a far greater bearing in corrosion problems than was commonly appreciated by water works men not dealing with boiler water treatment. Where waters were hard enough to lay down a carbonate film on the interior of pipes as the result of lime addition, that served as a protective coating to mains and service pipes but in very soft waters, unless hardness was artificially added, it appeared necessary to maintain a pH value of 9.6 or thereabouts if corrosion was to be controlled. At Providence, R. I., with a water of under 15 parts in hardness the same experience had been had as was had at Staunton. Others with very soft water to deal with had found pH correction of very questionable value unless it was carried considerably above the figure of 8.4 which had proved satisfactory with waters of 30 parts or more temporary hardness.

"Location of Service Reservoirs or Tanks and the Design of Pipe Systems to Secure the Most Effective Distribution of Water," by B. S. Parrish, Superintendent of Public Works, Martinsville, Va.

Mr. Parrish presented a discussion of the problem confronting him in Martinsville and methods employed in locating blockages in the distribution system which had accounted for low flows from certain fire hydrants where ordinarily pressures had been satisfactory during the average daily draught on the system. Having removed all acute difficulties, a study was under way and they were planning replacements and changes in the system to meet requirements for the next five years as the immediate steps to be taken. The pressure of necessity being relieved, he proposed a program to cover 20 years, which work being listed in order of importance and costs, could be carried forward as the markets and time became opportune.

M. C. Smith, Engineer of Water Supply and Electricity, Richmond, Va.

C. F. Bingham, Assistant Superintendent of Filtration, Richmond, Va.

Remedies to be considered in maintaining the desired pressures and fire-flows at various points on the system had included cleaning of mains and the strategic location of tanks or reservoirs on the system to reduce friction losses and pumping costs or possibly render feasible the use of pipe lines of smaller diameter than otherwise.

He had come to feel that some service storage should be located as near to the center of maximum consumption as practicable, rather than being located near the extreme ends of the system as had been most frequently practiced. In getting into the matter, he had found the study more complex than appeared on first blush and he did not feel that he could do more than outline the matter with the hope that his experience might be of value to others. He preferred to avoid drawing conclusions until by further studies he had satisfied himself that his final selection of a plan would represent the one best solution of the situation from all aspects.

F. J. Settee, Associate Professor of Engineering, the V. P. I., Blacksburg, Va., said that he thought that Mr. Parrish had brought out some very worthwhile points and that he was in agreement with him as to the suggested location of fire protection storage as near as practicable to the center of the system.

B. S. Parrish, Superintendent Public Works, Martinsville, Va.

Richard Messer, Chief Engineer, State Department of Health, Richmond, Va.

"Maintenance of Water Meters," by Chas. W. Davis, Jr., Superintendent of Water Works, Petersburg, Va.

Mr. Davis in recounting his experience with maintenance of 6,200 meters at Petersburg said that he had found that standardization on one manufacturer's meters had been very helpful in reducing cost of repairs and maintenance because of the readiness with which parts could be salvaged and reused or "borrowed" from new meters for use in old meters. In short, the advantage of interchangeability of parts was at its maximum when but one make of meter was being used. They had repaired 200 meters per year at an average cost of but $2.70 each which had been surprisingly low. He had found it highly profitable to spend a few days at one of the meter company's plants where he learned some of the "tricks of the trade," and particularly how to salvage parts by using acid bath treatment to clean them before replacement. His meter department consisted of 6 men, four being meter readers.

W. F. Day said, that Staunton's water rate was 60 cents per thousand gallons and monthly routine consisted of first removing any stopped meters and thereafter testing and repairing as many as possible that had been in service 6 years or longer. They frequently found meters under-registering by as much as 10 per cent. In handling complaints the consumer was always invited to witness the meter testing and that had been effective in reducing complaints and demands for testing.

D. R. Taylor, Superintendent Roanoke Water Works Co., Roanoke, Va., said that their requirement was a deposit of $1.00 for making a meter test for a consumer, with the agreement of a refund and adjustment of bill unless the meter was found to be under-registering. They had had to make about 10 complaint tests per year only. Aside from this 6,000 meters are being put through the meter shop for testing and overhauling each year.

E. F. Dugger, Manager of Water Works, Newport News, Va., said that meters would be tested on demand by his Meter Department upon one consideration only —that was that the complaining consumer be present to witness the test. This had reduced the number of complaints noticeably.

R. F. Wagner, Director of Water Service Lynchburg, Va., reported that the practice in Lynchburg was to require a $3.00 meter test deposit. If the meter was over-registering there was an agreement to refund the charge. He thought that the more effective procedure was to make an inspection for leaks on the consumers premises and thus frequently avoid meter testing. With this, **Mr. Ruehl** of Bluefield agreed. He said, from experience he could say that behind practically every complaint were leaky fixtures.

Ammonia-Chlorine Treatment Discussed

"The Reasons for and Difficulties Encountered in the Use of Ammonia-Chlorine Process at Richmond, Va.," by Marsden C. Smith, Engineer of Water and Electricity, Richmond, Va.

Mr. Smith in recounting the successful use of the ammonia-chlorine process at the Richmond filtration plant, prefaced his remarks by saying that the use of ammonia for taste prevention had its limitations but was of great value in allowing higher chlorine residuals to be carried in the finished water without objection from consumers and had considerable merit as a means of sustaining and prolonging disinfection effects. At Richmond the slower action of chlorine when ammonia had been added was of no consequence because the prechlorination practiced there rendered the water ultra safe. The ammonia was being applied to the filter effluent and another chlorine application followed it. The use of ammonia in the raw-water in conjunction with prechlorination had caused residual chlorine to pass through the filters and a terrific taste and odor production ensued because of reactions taking place within the dirty filter sand. Eventually complete "unloading" of the filters had resulted which had shown them a method of effective filter

D. W. Stubblefield, General Manager Belle-Alkali Co., Charleston, W. Va.

L. C. Bird, President Phipps & Bird, Inc., Richmond, Va.

bed cleansing and the ammonia chlorine treatment applied to filters temporarily removed from service was now an adopted practice as a means of keeping the sand bed clean. During the treatment the filter-to-waste valve was kept open and the unit thoroughly washed before its return to duty.

In the post-ammonia treatment they had complaints when starting the process. They had stopped it on this account and later a second attempt was made which was successful. In this the ammonia was started at a rate of but 1 pound to the million gallons and thereafter cautiously increased with careful watch on the gradually increasing residual chlorine. As the ammonia was increased the chlorine was decreased until eventually the ratio of 1 ammonia to 3 chlorine (by weight) was obtained and that had been maintained since. No complaints have resulted from the 0.4 parts of residual chlorine in the water leaving the plant nor the 0.25 parts reaching the consumers. Residual chlorine is now found at the most distant services from the plant and even in dead ends.

L. C. Hedgepeth, Development Engineer, Pennsylvania Salt Co.,, Arthur P. Miller, Engineer, U. S. Public Health Service.

Strangely enough consumers are now under the impression that there is no chlorine in the water, when in reality they had been consuming more chlorine than ever they had before.

The major benefits derived from the treatment at Richmond had been the maintenance of a water all over the system which contained no b. Coli or bacterial aftergrowths. In addition there had been an elimination of consumer's complaints and protection against chance contamination of the reservoirs and mains. The dead end complaints which had been the most prevalent, and really justified, had been eliminated and less frequent flushing of dead ends had been necessary since starting the treatment.

L. H. Enslow, in discussing **Mr.** Smith's paper, said that it was a pleasure and privilege to compliment Mr. Smith and his able staff on what had been accomplished in the way of improving the quality of the water supplied Richmond. It could be said without danger of refutation that the entire treatment as practiced at Richmond was as efficiently done as any on the American continent. The use of prechlorination, the improved coagulation and mechanical flocculation devised by Mr. Smith, the activated carbon applied just ahead of the filters, post ammoniation and chlorination with pH adjustment to control corrosion, constituted the "Alpha to Omega" in the most advanced practices of water treatment. When considering past conditions at Richmond and the difficult raw-water, containing waste from tanneries and sulphite pulp mills, what had been accomplished was the more impressive. Having lived in Richmond and having visited there frequently he could say that the water was never so palatable as has been the case recently and this even, as Mr. Smith had said, in the outlying districts where taste troubles had been usually the most pronounced.

Mr. Enslow discussed the relationship between the pH value, temperature and speed of disinfection when using ammonia with chlorination. Prechlorination was advocated to insure thorough sterilization and a large factor of safety. The use of activated carbon seemed to be a very sure way of removing tastes and the use of ammonia for just the purpose for which it has been employed in Richmond was already on the increase and bids fair to become standard practice. Where prechlorination was not employed and a short period of contact (less than 30 minutes) was available between chlorine application to the filtered water and use of the water by consumers, the chlorine might be added first and its rapid action be allowed to continue through to some selected point of ammonia application beyond. In such a scheme a somewhat greater quantity of chlorine would be consumed perhaps but the ammonia requirement would automatically become less.

The Richmond experiences with improved conditions on dead ends and the reduced need of flushing of mains had been most interesting and impressive. It was too frequently the case that water leaving the plant would be palatable, only to become foul before reaching the distant services. In as much as that condition, as well as greater corrosion and need for increased flushing, occurred conjointly with increased bacterial growth resulting temperature rise of the water in the mains, there appeared to be a soundness to the assumption that deposits at points of sluggish flow in the pipe system served as bacterial breeding grounds. In turn these depositions would putrefy to produce corrosion, foul tastes and odors, including sulphide of hydrogen. The carbon dioxide and sulphide and certain bacteria themselves had been responsible for increased corrosion and "red water" or "black water" as the case might be. A combination of products of decay (stagnation) and chlorine existing in the incoming water would perhaps result in the best possible conditions for production of foul tastes. It seemed logical to assume that maintaining residual chlorine throughout the system would suppress if not completely prevent biological changes resulting in putrefaction of deposited organic material. A serious offender in pipe systems is the iron loving bacterial growth—Crenothrix—which subsequently dies and decays to produce an extremely nauseating taste. It is well known that chlorine will control such growths. There may be other speculations as to why the ammonia-chlorine treatment results in improved conditions on the system but it perhaps can all be summed up into one explanation, viz.: suppressed or controlled biological activity. Experiences elsewhere had indicated as much.

(To be continued)

▼

LARGE STEAM GENERATOR.—Notable among the larger steam turbine generators recently completed was a triple tandem compound unit utilizing steam at an initial pressure of 1200 lb. to drive a single 150,000 KW., 18,000 r.p.m. generator.

A NEW CHEMICAL SEWAGE PURIFICATION PROCESS

By E. A. CAPPELEN SMITH*

UP to the present time, the most effective process for obtaining a purified sewage effluent has been the bacteriological process. For some time, chemical precipitation has been practiced, but the objection to such treatment has been that genuine or sufficient purification cannot be obtained because but little of the soluble materials are removed by chemical precipitation. In other words, the dissovled salts allowed to pass out in the effluent may or may not cause nuisance, depending upon stream conditions below the treatment works.

There has been developed at the Guggenheim Laboratories a process of purifying sewage effectively by elimination and complete disposal of not alone the suspended matter, but also most of the dissolved salts. The new process is not a sensitive one; any change in sewage or other conditions can be met effectively and promptly.

The process consists essentially of four steps:

I—Removal of suspended solids by coagulation with iron compounds and lime, and settling the coagulated solids in the form of a sludge.

II—Disposal of the sludge by filtration and complete incineration.

III—Removal of the basic nitrogen compounds, together with attendant groups containing carbon, hydrogen, sulphur, etc., by an exchange reaction using a preferred type of zeolite.

IV—Regeneration of the zeolite and thereby concentration of the basic nitrogen compounds in the salt solution, and subsequent recovery of ammonia from this solution.

Character of Influent Sewage

New York City sewage from the Dyckman Street outfall has been used in the operation of the demonstration plant for a period of about eight months. The sewage treated has been taken from the Dyckman Street outfall covering the entire day, and the plant has been operated over sufficient length of time to cover seasonal variations. This sewage is of the following character:

Suspended solids	Average 200 p.p.m.	
B. O. D. (5 days)	Average 150 p.p.m.,	with variation from 100-325 p.p.m.
Total nitrogen	24-28 p.p.m.	
Ammonia nitrogen	12-14 p.p.m.	
Bacteria	3,000,000-6,000,000	colonies/cc

***Step I—Removal of suspended solids by coagulation with lime and iron, and settling the coagulated solids in the form of a sludge.*

The incoming sewage is treated first with soluble iron, in the form of ferric sulphate. Complete and prompt diffusion of the solution is obtained by air agitation.

Time of retention	5 minutes
Iron concentration	40 p.p.m. of iron or 140 p.p.m. of ferric sulphate
Air requirements	.07 cu. ft./gal.

Following the application of ferric sulphate, the sewage passes to a "flocculator" wherein lime is added, under controlled conditions, in the form of milk of lime.

Lime consumption	60 p.p.m. of burned lime
Time of retention	5-10 minutes

From the "flocculator" the material passes to a clarifier, into which the sewage is introduced at the circumference near the bottom, passing upward through a blanket of sludge. The pH values throughout the system are controlled and maintained, preferably from 6 to 8, although the system is operated very satisfactorily over a wider range, namely, from 5 to 9.

As a result of the foregoing treatment, complete flocculation and coagulation are obtained, ferric hydroxide is formed, and the suspended solids are effectively precipitated.

Settling area of clarifier	1,000 gals./sq. ft./day
Suspended solids in sewage entering clarifier	350 p.p.m. average
Suspended solids in supernatant liquid	10 p.p.m. average

Up to this point, approximately 60 per cent of the putrescible material has been removed and the total nitrogen reduced from 28 p.p.m. to 15 p.p.m., about 12 parts of which are present as ammonia nitrogen.

***Step II—Disposal of the sludge by filtration and complete incineration.*

The sludge from the bottom of the clarifier is pumped to a suction filter, where the moisture content is reduced by about 20 per cent.

Moisture content, sludge entering filter	93%
Moisture content, filtered sludge	70-75%
Filtration rate	7 lbs./sq. ft. of filter surface/hr.

The sludge cake from the filter is completely destroyed

*Member of the firm of Guggenheim Bros., 120 Broadway, New York City.

**An accompanying flow sheet and views of the experimental plant used in developing the process will serve to amplify the written description to follow.

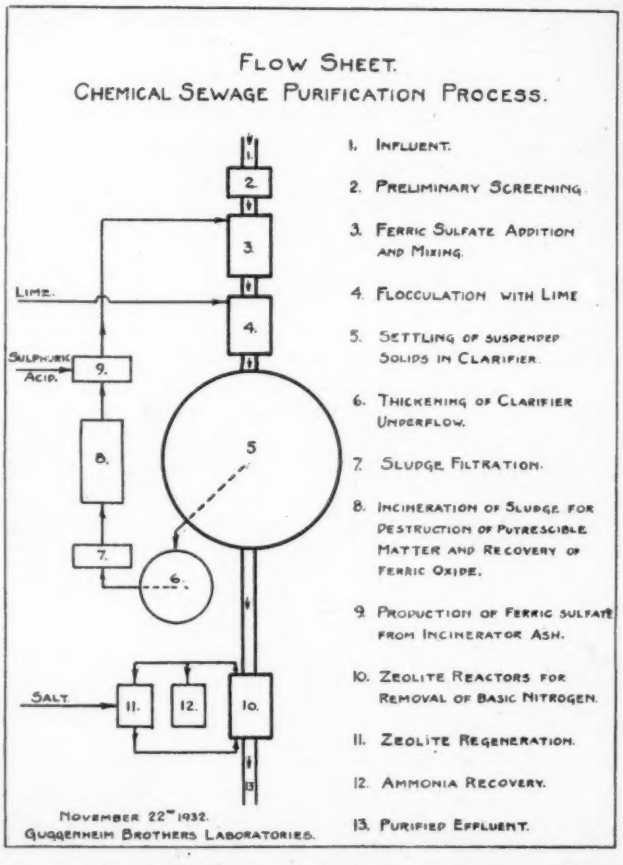

FLOW SHEET.
CHEMICAL SEWAGE PURIFICATION PROCESS.
1. INFLUENT.
2. PRELIMINARY SCREENING.
3. FERRIC SULFATE ADDITION AND MIXING.
4. FLOCCULATION WITH LIME
5. SETTLING OF SUSPENDED SOLIDS IN CLARIFIER.
6. THICKENING OF CLARIFIER UNDERFLOW.
7. SLUDGE FILTRATION.
8. INCINERATION OF SLUDGE FOR DESTRUCTION OF PUTRESCIBLE MATTER AND RECOVERY OF FERRIC OXIDE.
9. PRODUCTION OF FERRIC SULFATE FROM INCINERATOR ASH.
10. ZEOLITE REACTORS FOR REMOVAL OF BASIC NITROGEN.
11. ZEOLITE REGENERATION.
12. AMMONIA RECOVERY.
13. PURIFIED EFFLUENT.
LIME.
SULPHURIC ACID.
SALT.
NOVEMBER 22ND 1932.
GUGGENHEIM BROTHERS LABORATORIES.

Fig. 1—Flow Sheet of the Chemical Sewage Treatment Process, Developed in the Guggenheim Bros. Laboratories

in a rotary kiln incinerator consisting of two sections, namely, a drying section and a burning section.

Moisture content, incoming filtered sludge.....70-75%
Temperature, entering end of dryer.....150° C.
Temperature, exit end of dryer.....110° C.
Moisture content, dried sludge.....12-15%

The dried sludge is fed into the incinerator section, where all putrescible material is completely destroyed by burning.

Incinerating temperature .....650-700° C.
Calorific value of sludge.....4500-5000 B. T. U./lb. by Bomb calorimeter test.

The ash, consisting of ferric oxide and some silica, is then treated with sulphuric acid for the regeneration of the ferric sulphate, which is again used for coagulation.

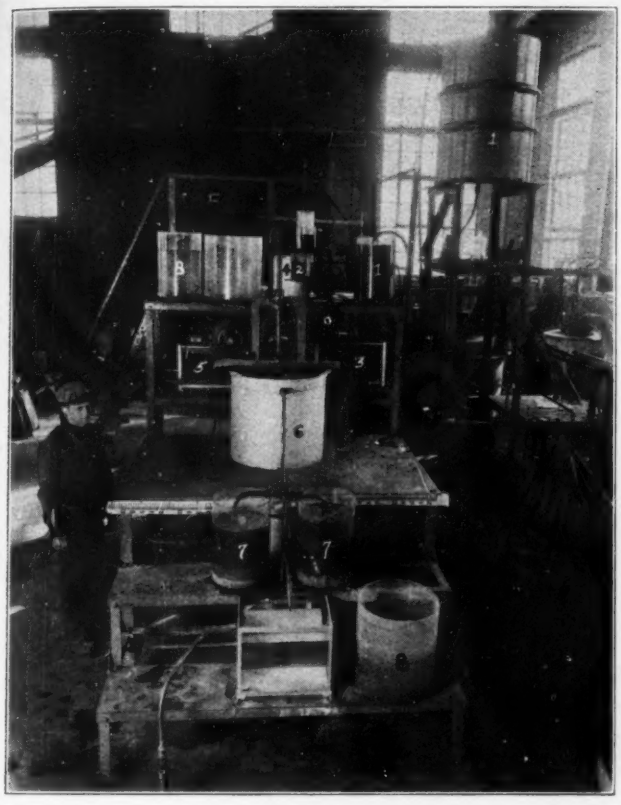


Fig. 2—Demonstration Plant Chemical Sewage Purification Process; Capacity 2,500 Gallons per Day

1—Crude sewage feed; 2. Ferric sulphate feed; 3. Ferric sulphate mixing and coagulation; 4. Lime feed; 5. Lime mixing and flocculation; 6. Clarifier; 7. Zeolite reactors; 8. Brine wash for regeneration of zeolite reactors; 9. Final effluent.

The small amount of insoluble matter, consisting principally of silica, remaining after the treatment of ferric oxide with sulphuric acid, is filtered off and discarded.

Step III—Removal of the basic nitrogen compounds, together with attendant groups containing carbon, hydrogen, sulphur, etc., by an exchange reaction using a preferred type of zeolite.

The supernatant liquid from the clarifier passes through a specially prepared zeolite reactor bed. In this operation, the basic nitrogen, principally ammonia, is exchanged for the sodium in the zeolite in the same manner as hardness is removed by other zeolites. As a result, there is a high concentration of ammonia in a very small volume of reactor.

Amount of zeolite required.....16,000 lbs. per million gallons sewage treated
Rate of loss of zeolite.....2.5 to 4% per year

Step IV—Regeneration of the zeolite and concentration of the basic nitrogen compounds in a solt solution, and recovery of ammonia from this solution.

After ten or twelve hours, the flow is diverted from one zeolite reactor to another, the first one being regenerated by a backwash of salt water, containing approximately 20 per cent sodium chloride. By this operation, the ammonia transfers from the zeolite to the salt solution. The ammonia is recovered from the solution in a suitable type of standard equipment.

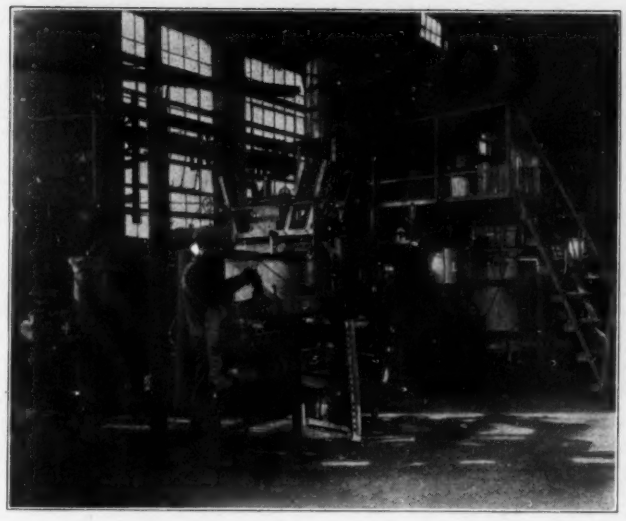


Fig. 3—Demonstration Plant Chemical Sewage Purification Process; Capacity 2,500 Gallons per Day

Slude Disposal Section: 1, Sludge thickener; 2, Vacuum filter; 3. Filter cake dryer and incinerator; 4. Acid leaching of incinerator ash for recovery of ferric sulphate.

Ammonia content of supernatant liquid 12 p.p.m.
Concentration of ammonia in backwash. 2.2 g.p.l.
Ratio of ammonia in backwash to ammonia in sewage..... 200 to 1
Amount of backwash required.....0.5% of sewage flow
Recovery of ammonia (NH_3)..... 100 lbs. per million gals.

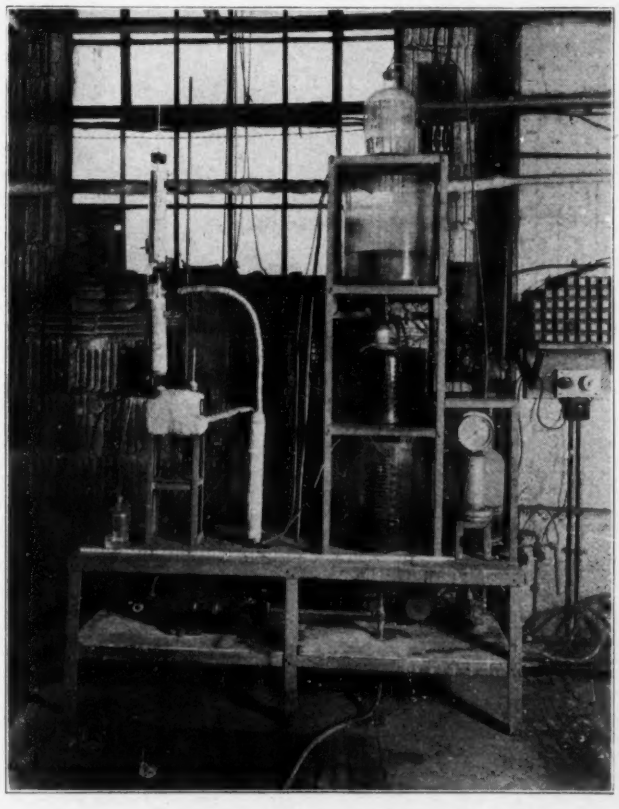


Fig. 4—Demonstration Plant Chemical Sewage Purification Process; Capacity 2,500 Gallons per Day. Ammonia Recovery Plant

Comparison of Raw Sewage with Purified Effluent

	Raw Sewage	Purified Effluent
Suspended solids	Average 200 p.p.m.	0
B. O. D.	Average 150 p.p.m., with variation from 100 - 325 p.p.m.	5 p.p.m.
Total nitrogen	24-28 p.p.m.	2 p.p.m.
Ammonia nitrogen	12-14 p.p.m.	0.5-1.0 p.p.m.
Bacteria	3,000,000-6,000,000 colonies/cc.	
Bacteria removal		99.8%

Equipment and Materials

The equipment used throughout the process was patterned after standard equipment which has been employed for similar purposes either in sewage disposal plants or in other industrial operations. Ratios between rates of flow, tank area and filter size have been maintained to stimulate those employed in actual practice. The materials used, namely, sulphuric acid, burned lime and common salt, are among the cheapest of heavy chemicals and are readily available.

Plant Construction and Expenditure

Preliminary designs made to date on plants varying from 25,000,000 to 200,000,000 gallons of raw sewage per day indicate that the space required for this type of plant is about 50 per cent of that required for an activated sludge plant.

Our study leads us to believe that one of these plants can be installed at a cost of approximately two-thirds of the cost of an activated sludge plant. The cost of an activated sludge plant, having a capacity of 50,000,000 to 200,000,000 gallons per day of raw sewage, built under conditions existing on the Atlantic seaboard, Chicago or the Lake cities, is approximately $100,000 per million gallons per day, as compared to an estimated cost for a chemical process plant of like capacity of approximately $65,000 to $70,000 per million gallons.

Cost of operation:

Our estimates indicate that the cost of operating and maintaining a chemical process plant within the size range mentioned above, would be about	$22.00/m.g.d.
Interest and amortization charges, based on 7½% of capital cost, would be about	14.00/m.g.d.
Making a total cost for operation, maintenance and capital charges of about	$36.00/m.g.d.

All of the above figures are based on prices for material and labor existing in the eastern section of the United States or in the Lake cities at the present time, and might vary up or down for other localities in the United States or the rest of the world.

The development of the above described process was initiated and carried forward under the direction of Major Geo. H. Gleason, Chemical Engineer, with the cooperation of Mr. Alfred R. Loonam.

▼

New Albany Water Supply in Use

The new water supply of the city of Albany, N. Y., was turned into the distribution system on November 10. Although the works were practically completed one year and a half ago, serious leaks and construction difficulties at the distribution reservoir prevented the use of the supply.

The water is obtained from a reservoir at Alcove (about twenty miles from Albany) which impounds the flow of the Hannacrois and Basic Creeks. From this reservoir, which holds nearly a two years' supply, the water flows about ten miles through a forty-eight inch cast-iron conduit to the filtration plant at Feura Bush, where it is filtered and chlorinated before being delivered to the city. The surplus goes to a 100,000,000 gallon reservoir at Loudonville. These works cost approximately $9,000,000.

Rules and regulations have been enacted by the State Department of Health for the protection of the supply from contamination and are being enforced by the city authorities.

▼

Draglines on Louisville Sewer Construction

The size of the undertaking and several unusual features have been attracting considerable interest in the construction of the Southwestern outfall sewer in Louisville, Ky.

To shorten the haul of wet concrete, the contractors moved their mixing plant to a point less than a mile from the finish line. The aggregates and cement were handled by rail and truck. A steel derrick maintained a stock pile and served the plant. Gasoline locomotives hauled the cars to the pouring spots, where the concrete was dumped on to a short inclined belt conveyor that carried it out toward the middle of the ditch and to a height permitting it to flow to the top of the arch forms. For inverts, the concrete was dropped direct by chutes. The poured concrete tunnel is 27 ft. 6 in. wide, inside dimensions.

In back filling a large followboard was pulled in by a 2-yard crawler crane in the ditch, and returned to the pile by a smaller machine standing in the spoil pile at a considerable distance. It proved to be a rapid method of getting the earth back in place. Six Link-Belts on the job, were used as draglines and cranes—four of these being new full-two-yard heavy-duty machines.

The illustration shows a close view of excavating operations. At this point the excavation was 65 ft. deep. This kind of work requires long hauls of the loaded bucket, and long radius swings through a big arc. When continued at high speed for 20 hours out of every day for six days a week, it becomes a good endurance test on excavating equipment.

Sewer Construction at Louisville, Ky., with Draglines

MISSOURI WATER AND SEWERAGE CONFERENCE

WITH the largest registration in its history, the Missouri Water and Sewerage Conference held a two-day session at Sedalia, Mo., on Oct. 13 and 14, which marked the eighth annual meeting of this organization.

Charles H. Spaulding, Chemist and Superintendent of Water Purification at Springfield, Ill., was guest of honor and opened the technical session with a paper on "What Operators on Water Purification Are Thinking About." He spoke of the efforts to produce better water at less cost and said that softening, elimination of typhoid and taste and odor control were the primary considerations of most superintendents as they strive to improve quality. He described savings which softening had brought about at Springfield, the reduction in typhoid there, and their efforts at quantitative odor measurement and prevention. [See article in this issue by John R. Baylis.]

A. V. Graf, Superintendentent at St. Louis, was not present. In his paper, "When and How to Wash a Filter," he described difficulties encountered in filter washing and stated that experience was the most effective guide as to when to wash a filter. He advocated the use of a filter effluent turbidity indicator as a good guide. He suggested using as high a sand expansion as practicable without loss of filter sand. In discussion, Mr. Spaulding described a grid surface wash device and the use of an ordinary hose and nozzle in improved filter washing.

Herbert Hartung of University City described "Bacteriological Laboratory Control" at his plant. He stressed the value of the ammonia-chlorine treatment. Open reservoirs and dust contamination necessitate close control. Floating agar plates placed in reservoirs indicated a high bacterial and b. Coli contamination from dust, etc. Residual chlorine tests are made every hour at the plant and every two hours in the reservoirs and once daily out on the distribution system. **J. P. Smouse** of the St. Joseph Water Company, described the chlorine-ammonia control measures used by them.

Roger Higgins of Chillicothe described laboratory chemical control of the lime-soda softening plant indicating the necessity of adjusting theoretical quantities of chemicals to local waters. He stressed the value of carefully kept records and the savings effected by proper control.

Carl Haynes, Superintendent at Moberly, Mo., described his "Experiences with Activated Carbon Treatment." His had been the first plant to use carbon in Missouri and he claimed very beneficial results also from the use of "H. T. H." for algae control in the lake. It appeared that the use of activated carbon in basins where coagulation without filtration constitutes the purification process had also proven very satisfactory.

Prechlorination was also discussed and was credited as effecting a saving in alum dosage, and wash water.

Water Rates Discussed

At the afternoon session, **Mr. R. E. Duffy** of the Missouri Public Service Commission presented a paper on "Determining Proper Water Rates for Smaller Cities," in which it was stressed that the chief function was to furnish good water for the use and convenience of citizens at their homes. Fire protection and lawn sprinkling were of secondary consideration, notwithstanding the fact that in small cities often half the water works capacity is for fire service. He suggested a 3 part charge for water which would include (1) demand cost, (2) cost of quantity used and (3) fixed costs to take care of depreciation and bond interests.

W. B. Rollins of Kansas City, in a paper on "The Use of Copper Service Pipe," described its application, resistance to corrosion and the increased use of copper tubing in water works practice.

H. E. Newell of Webb City described "Painting Standpipes and Elevated Tanks" from the inside. He stressed the value of thoroughly cleaning by scraping, chipping and wire brush treatment. Badly pitted areas should be repaired by electric spot welding. Paint was best applied while the tank was hot from the sun and then let dry very thoroughly prior to use. About 72 hours was allowed to lapse between the last coat of paint and putting the tank into service. He warned of the necessity of proper ventilation while painters were at work and said that it always paid to use men who knew their business and not just any fellow who could use a brush.

W. H. Henby, General Manager of the St. Louis Water Company at University City, described their practice of insuring properly functioning hydrants all year round. Unfamiliarity with the way hydrants turn often results in the stem being twisted off. In-

8th Annual Missouri Water and Sewerage Conference, at Sedalia, Mo.

crusting chemicals often make it necessary to open and close the hydrant twice to insure a full opening. Adequate drainage under the hydrant is very desirable. Oil and graphite make a good mixture to grease the upper threads. Painting the hydrants black with an asphalt paint and using aluminum paint on the cap makes a pleasing and durable combination. He recommended that a thorough inspection be made between Oct. 1 and Nov. 15 for placing the hydrant in condition for winter service.

W. E. Barnes, City Engineer and Superintendent of Water Works at Liberty, read a paper on the "Method of Preparing and Collecting Water Bills."

Sewage Treatment Topics

G. R. Scott of Black & Veatch, Consulting Engineers of Kansas City, presented a paper on "Recent Developments in Sewage Treatment," illustrating his paper by moving pictures taken at the Dodge City, Kan., separate sludge digestion plant.

In the Round Table discussion which followed, **Ralph E. Fuhrman** of Kansas City, outlined some "Laboratory Control Tests used at Sewage Treatment Plants." He regretted that many city officials do not appreciate the value of making tests and keeping records. They looked at it from an expense angle without realizing the dangers from law suits which might be lost in the absence of necessary records to fight them.

George S. Russell, Consulting Engineer, St. Louis, described the "Collection of Gas for Heating Sludge. He said, that savings in structural costs are effected by heating the digesting sludge. Special devices are necessary, but their expense is offset by the overall savings effected.

W. Scott Johnson, Chief Engineer, State Board of Health, Jefferson City, described the various types of streams in Missouri and stated that aside from the Missouri and the Mississippi rivers no stream should receive sewage unless primary treatment has been given it as the minimum. In the Southwestern industrial (mining) section of the state only primary treatment to prevent nuisance is necessary. Each case should receive specific study and each plant should be carefully planned. Statewide administrative control is needed and the existing state laws are woefully archaic.

A. W. Kirby, Manager of Utilities, Marshall, Mo., described the operation of the $35,000 zeolite iron removal-softening plant there and gave the reasons for the selection of this type of plant over a lime-soda plant.

Herman C. Henrici of Kansas City discussed the "Economy of Proper Selection of Pumps." He described plunger type, air lift and deep well centrifugal pumps and discussed efficiencies of each under parallel conditions.

New Officers

The Association elected as Chairman W. E. Barnes, City Engineer of Liberty; as Vice-Chairman, L. P. Andrews of Sedalia; Secretary-Treasurer, Herbert Bosch, State Board of Health, Jefferson City, Mo.

Following an inspection tour of the water works and filter plant, the Sedalia Water Company was host to the conference at luncheon served at the Country Club, through the courtesy of Mr. L. P. Andrews, president of the company. Later the two sewage treatment plants were visited also.

Water Works to Cost Over $500,000,000 Needed

Needed sewerage and water works projects to cost $802,918,000 that are being held up because of the poor market for bonds are listed in a pamphlet issued recently by the National Committee for Trade Recovery, 330 West 42d St., New York City. The pamphlet tells how funds can be obtained from the Reconstruction Finance Corporation for financing construction of such projects for the relief of unemployment.

Water Works Improvements Needed.—Following is the list showing the number and total cost of needed water works projects that are being held up because of the poor market for bonds. These projects can be made self-liquidating and eligible for loans from the Reconstruction Finance Corporation.

State	Number of Projects	Total Cost of Projects
Alabama	24	$354,000
Arkansas	3	239,320
†California	9	275,503,000
Colorado	13	5,643,500
†Connecticut	1	500,000
Delaware	7	165,000
Georgia	2 & misc.	10,186,000
Idaho	9	997,750
†Illinois	24	5,684,000
‡Indiana	38	5,814,000
†Iowa	4	508,000
Kentucky	25	2,108,000
Louisiana	4	670,000
Maryland	35	8,172,000
†Massachusetts	106	16,896,000
Michigan	2	638,000
†Minnesota	3	2,400,000
Mississippi	13	613,000
†Missouri	9	622,000
Montana	15	582,500
†Nebraska	1	500,000
†New Jersey	3	54,700,000
New Mexico	6	207,500
†New York	22	114,147,000
†North Carolina	13	1,027,000
Ohio	1	20,000,000
Oklahoma	7	1,256,100
Oregon	2 & misc.	1,265,000
Pennsylvania	2	2,300,000
†Rhode Island	3	925,000
†South Carolina	2	1,200,000
Tennessee	4	100,000
Texas	42	2,200,000
Utah	13	1,085,000
Vermont	2	60,000
Virginia	1	1,268,000
Washington	3	1,452,000
West Virginia	13	622,000
†Wisconsin	22	5,395,000
Totals	*508	*$548,005,567

*Incomplete totals. No reports received from 9 states.
†States that are making preparations to pass legislation in January, 1933 that will enable their municipal governments to avail themselves of federal funds for financing self-liquidating public works.
‡Enabling acts passed at special session, September, 1932.

▼

MERCURY VAPOR PROCESS POWER STATIONS.—The two 20,000 kw. mercury vapor process power stations at Kearny, N. J., and Schnectady, N. Y., were nearing completion at the close of the year. These unique equipments, which will operate turbines with mercury vapor at 125 lb. pressure, are expected to produce both electric energy and steam at a lower fuel cost than has ever before been attained.

FILTRATION PLANTS

A Section Dealing with Their Design, Construction and Operation

Conducted by JOHN R. BAYLIS, Associate Editor

Physical Chemist, Bureau of Engineering, Chicago, Ill.

PROCEDURE FOR MAKING ODOR AND TASTE DETERMINATIONS

INCREASED interest in the prevention and removal of objectionable odors and tastes from water renders it important that efforts be made to improve methods for evaluating odors and tastes. The procedure given in Standard Methods of Water Analysis of the A. P. H. A. for odor determinations falls short of our needs at the present time. Spaulding,[1] in 1931, suggested that dilution with odor free water to find the "threshold point" would be a better method than that given in Standard Methods in that it gives some idea of the amount of the odor or taste present. Later Spaulding[2] suggested that the odor or taste be defined in accordance with the dilution required to obtain the "threshold point." An odor requiring a dilution of 10 times the original volume of the water would be given an odor intensity value of 10. Dilution to determine the threshold point has been used heretofore in studying industrial wastes, but the writer is not aware of it being used in water purification prior to Spaulding's suggestion.

There is considerable merit in the method in which the odor "threshold point" is determined, and there is also some merit in the procedure given in Standard Methods. The writer suggests that both methods be used in part and that both be modified to give more exact determinations. Objectionable odor in drinking water, or in foods and beverages in which the water is used, must be capable of detection; otherwise it would not be objectionable. The main trouble with present methods of odor determination is that the individual making the test frequently does not detect odors that are later detected by consumers of the water. The writer will give a procedure which appears to be capable of detecting the odor in concentrations lower than can be detected by those with a very keen sense of smell who drink the water.

Standard Methods recommends for the cold odor test that the sample be shaken violently in one of the collecting bottles when it is about half to two-thirds full, remove the stopper, and smell the odor at the mouth of the bottle. For the hot odor test it recommends that about 150 cc. be placed into a 500 cc. Erlenmeyer flask, cover the flask with a well fitting watch glass, heat the water *almost* to boiling on a hot plate, remove the flask from the plate and allow to cool not more than 5 minutes. Agitate with a rotary motion, slip the watch glass to one side and smell the odor.

The procedure for both the cold and hot tests allows considerable mixture of the surrounding air with the air containing the odor when it is being drawn into the nostrils. It seems that the best procedure would be one that allows the least dilution of the odor producing substance by air drawn in. Use of the nose-piece shown in Fig. 1 prevents outside air from mixing with the inside air to any appreciable extent as it is being breathed and has been very helpful in routine odor determinations. An odor which cannot be detected in the hot test in this manner is not likely to be detected by any one consuming the water or products in which the water is used.

Johnson[3] distills over about 100 cc. of water from a 500 to 600 cc. sample and makes the taste and odor test on the distillate. This probably is a very good way of concentrating part of the odors in the water. It is not believed that the distillation is necessary when the procedure outlined below is used.

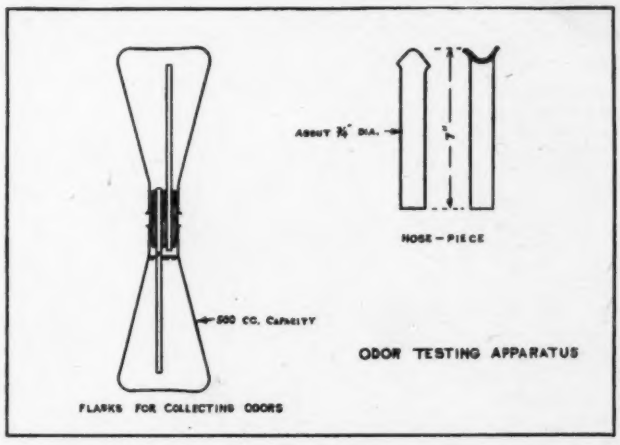


Fig. 1—Simplified Odor Testing Apparatus

Dilution Water.—The dilution water should be clear and it should be taste and odor free. It should preferably be prepared from the city's water where the test is to be made. This for the reason that the diluting water should contain approximately the same amount of dissolved mineral constituents as the water to be tested. Taste and odor free water may be prepared by passing tap water through a bed of activated carbon, or by adding an excess of the powdered carbon and later filtering to remove the carbon. A glass tube about 5 feet long and about 1¾ inches inside diameter filled about 4 feet with granular carbon of about ⅛ inch size will make a suitable unit. The carbon should be well washed. A very good plan is to let water run through the new carbon bed for several hours before collecting the effluent.

A good grade of granular activated carbon such as "Hydrodarco" or cocoanut-char should be used. Just before using the carbon unit to prepare the water for dilution purposes, pass through enough water to flush out the water left standing in the unit. Clean bottles which have been stored full of water for at least 24 hours before use, emptying the bottles just before filling with the water from the carbon unit, should be used for dilution water. By keeping the bottles stored in the dark

and filled with clear water which is free from tastes and odors, there should be no trouble from the water absorbing taste or odor from the sides of the bottles. The filter should be run at a rate not to exceed two gallons per square foot per minute, and it probably will be best to run at a slower rate after the unit has been used for a short time. Always keep the carbon submerged with water and change the carbon every few months.

If powdered activated carbon is used for preparing taste and odor free water, wash the carbon thoroughly and apply about 400 to 500 parts per million of the dry material. Stir or agitate frequently for about one hour. Filter through a well washed filter paper into a clean bottle. The end of the funnel should project well into the bottle to prevent absorption of odors from the air. The bottles for storing the dilution water should be stored full of water as recommended in the previous paragraph.

What is intended in the preparation of taste and odor free water is to have the water entirely free from any compound which will produce taste or odor if present in sufficient concentration. Suppose that 1.0 p.p.m. of some compound will produce a barely detectible odor, then a concentration of 0.8 p.p.m. cannot be detected. If the water to be tested contains 2.0 p.p.m. of the odor compound, and the dilution water contains 0.8 p.p.m., the threshold point will be found to be at a dilution of about 5 with this water, whereas it would be at only 1.0 if the dilution water was entirely free from the compound and contained no other compounds which would affect the results. The importance of having water absolutely *free* from taste and odor compounds cannot be stressed too strongly, because the success of the dilution method depends almost entirely upon the dilution water. Most odor compounds are volatile and therefore cannot be removed by distillation. Distilled water is not suitable unless it is treated with activated carbon, and even then it is not believed to be as good as the tap water which is prepared by treatment with carbon.

Making the Determination.—Use glassware that has been very thoroughly cleansed. First make a cold and then a hot odor test on the undiluted sample and record the intensity of the odor as defined in Standard Methods of Water Analysis. Thereafter proceed as follows:

Fill a 500-cc. flask nearly full of the water. Fasten another flask of the same size to this flask in the manner shown in Fig. 1. Us cork stoppers, or rubber stoppers which have been covered with tinfoil. By inverting the flasks so that the full one will be on top, the water will begin to run down to the lower flask. When the water is about evenly divided in the two flasks, tilt the flasks on side and shake vigorously for about 10 seconds, then stand on end so that all of the water will run into one of the flasks and remove the upper flask with stoppers attached. Do not remove the stopper until ready to make the test and if there is an interval of more than a few seconds before making the test, stop up one of the small glass tubes to prevent the vapors inside from flowing out. This is especially important if the inside air is warmer than that in the room. When ready to make the odor test, remove the stopper, insert the nose-piece and draw the air within the flask into the nostrils. In this manner air which has been in close contact with the water will at first be drawn into the nose without much dilution from the surrounding air.

The nose-piece shown in Fig. 1 is easily made from a piece of glass tube about three-fourths to seven-eighths inch in diameter. Heat the end, flare the tube a little, grind to fit the nose, then heat again so as to make a smooth edge on the glass. With the aid of a mirror it is not difficult to shape the glass so as to fit the shape of an individual nose.

The hot odor test is made by heating the water to about 80 degrees C., and proceeding in the same manner as for the cold test. The air in the flask must be allowed to cool to the point where it will not be too hot for breathing before inhaling. To avoid excessive squirting of the water from the flasks while shaking, it is well to heat the air in the empty flask to approximately that of the water. This can be done by inserting the stopper in the empty flask and setting it in a water bath of the desired temperature for a short time. A watch glass can be placed over the flask containing the sample of water being tested until it has been heated to the desired temperature. The same sample used for making the cold odor test may be used for making the hot odor test though it is believed if great accuracy is desired that a fresh sample should be used.

Determining the Threshold Point.—From the intensity of the odor found by testing the undiluted sample, make a guess as to the probable "threshold point." Prepare dilutions with odor free water to be both greater and lesser than the predicted threshold dilution. For accurate work at least 5 dilutions should be prepared. One sample should be the predicted dilution, two should be lesser and two greater. If a dilution of 10 is predicted, prepare dilutions of 6, 8, 10, 12 and 14. Test each dilution, beginning at the highest and going to the lowest. Record the intensity and quality of the odor of each dilution. If the highest dilution still contains an odor, predict from its odor the approximate threshold point and make up another set of dilutions. At least one dilution should have no perceptible odor, and at least two dilutions should have the odor. The threshold point should be determined for both cold and hot conditions. It will be found that some odors require considerably higher dilution to reach the threshold point while hot than when cold.

It is possible that the individual making the odor tests will not care to use the double flask procedure. In this case fill a 500 cc. or 1,000 cc. flask about one-half full, stopper tightly enough to allow violent shaking, then project the nose-piece into the flask nearly to the water level and inhale. This appears to be about as accurate as using the two flasks for the cold test, but if the sample is heated to about 80 degrees for the hot test, this is entirely too hot for breathing.

Taste Tests.—Taste tests may be made on samples of water where it is known that the water is safe for drinking. In most instances the odor test will be sufficient, but there probably are a few tastes not readily detected by the odor test. The taste test should be made at the natural temperature of the water, at about 20 degrees C. if the natural temperature varies more than about 5 degrees from this temperature, and also at about 50 degrees C. Taste tests can be made on the various dilutions before making the odor tests.

It has been suggested by F. E. Stuart that the mouth be rinsed with hot distilled water just before making the taste test. It is believed that this is a very good suggestion and may result in giving a keener detection of taste and odor.

References

[1]Spaulding, C. H. Quantitative Determination of Odor in Water. Am. Journal of Public Health, 21: 1038-9, Sept., 1931.

[2]Spaulding, C. H. Some Quantitative Odor Determinations. Jour. Am. Water Works Association, 24: 1111-8, August, 1932.

[3]Johnson, B. F. Taste and Odor Control with Activated Carbon. Jou. Pennsylvania Water Works Operators' Association, 4:43-52, 1932.

INDUSTRIAL WATER SUPPLY ·AND TRADE WASTES·

EVAPORATION AS A PROCESS OF RECLAMATION AND PREVENTION OF STREAM POLLUTION

By H. O. CHUTE

Chemical Engineer, 50 East 41st Street, New York, N. Y.

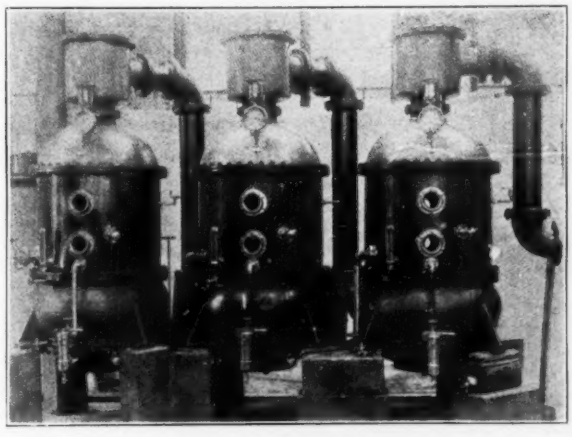
MANY chemical processes give wastes with a very low content of solids forming a very dilute solution. If the solids are organic and capable of fermentation and oxidation by biochemical means they can be treated by the well known methods of sewage treatment.

H. O. Chute

Some industries produce wastes of such quantity and concentration that only by practically eliminating them can stream pollution be avoided. With strong solutions of organic or inorganic solids it is sometimes possible to convert these into marketable products, thus removing them from the class of wastes and putting them into the class of valuable by-products. At a very early day it was customary in the Michigan forests to operate wood distillation plants by carbonizing in kilns and recovering the smoke and condensing it to pyroligneous acid from which wood alcohol was distilled and the residue of tarry acetic acid and other pyrogenous impurities was thrown to waste. As the plants increased in size and population became more dense the nuisance had to be eliminated. The writer was fortunate, after becoming familiar with this situation, to have gone to Cuba in connection with the sugar business. This industry has always led in the use of multiple effect evaporation, made economical by the use of waste steam from the mills.

After many years of effort the wood distillers were induced to put in improved plants for distilling the residual pyroligneous acid and evaporating the acetate of lime formed by neutralizing the distilled acid in multiple effect vacuum pans. Exhaust steam for the purpose was available from the blowing engines of the blast furnaces with which the charcoal kilns were associated. In order to get a concentrated solution certain modifications in distilling methods were introduced by which a "calandria" was substituted for the live steam formerly introduced into the acid to distill off the alcohol. This eliminated the dilution caused by the introduction of live steam into the still. As the thermodynamic effect of the steam had been utilized in the blowing engine and since that had formerly gone off as free exhaust, the heat was considered free and this process not only removed a source of stream pollution but gave an important by-product which could be sold at a price that materially increased the profits of the business. Michigan thus became a large producer of acetate of lime.

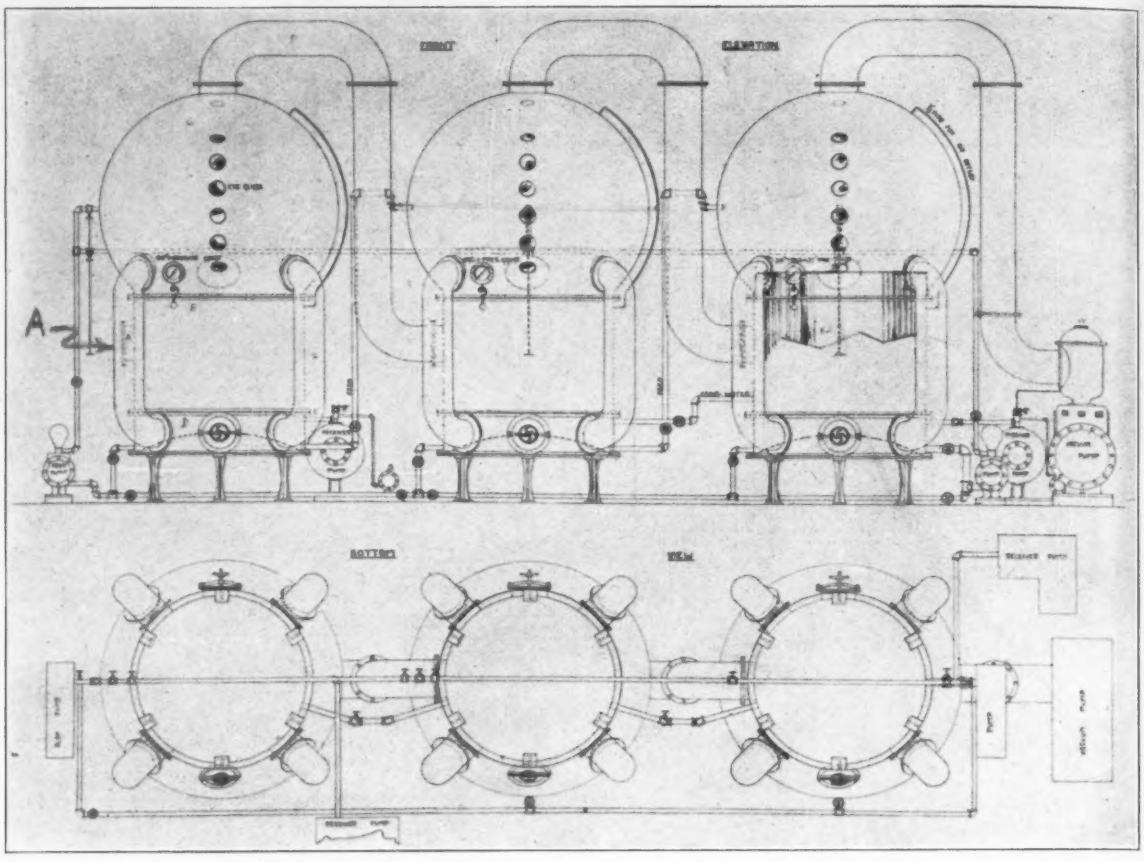
In an early day the slaughterhouse produced a large amount of offal which was wasted. More as a method of getting rid of a nuisance than as a method of making money the process of rendering the inedible parts of the meat and the other offal was introduced. This consisted in boiling the mass to a thick soup and when cooled had a layer of grease on it which could be skimmed off and



Triple Effect Evaporator

used in soap making. The shredded meat and small bones settling to the bottom were taken out and pressed and dried to form "tankage." There remained the liquid "consomme" which was concentrated in multiple effect evaporators to a heavy glue called "stick" which was dried in pans and when solid was added to the tankage which was sold for fertilizer purposes. This solved the problem of stream pollution but later improvements enabled the packers to sell this product for chicken and hog feed and it is now one of the important by-products of packing houses.

The paper and pulp mills which produce chemical pulp all have strong waste liquors from the "cooking" process which disolves out the non-cellulose parts of the wood. The soda process was the first to introduce the Yaryan multiple effect process to concentrate the soda liquor to a heavy syrup which was burned to a black ash which in turn was leached to dissolve and recover the soda. After causticizing the crude soda liquor this was returned to the process for treatment of succeeding batches. Mills utilizing the sulfate process have adopted the same general scheme and mills utilizing these two processes are faced with little or no stream pollution problems.



Details of Triple Effect Evaporator. Designed and Used by the Author

The sulfite pulp producing process as now carried on gives a residual liquor with about 10 per cent solids of which about two per cent are fermentable sugars. These have been converted into alcohol, but without profit. A number of years ago the Robeson Process Co. began the evaporation of this residue in multiple effect vessels after treatment for neutralization. The concentrate was originally produced as a core wash for foundries. It served as a satisfactory core compound and no trouble was experienced with the workmen taking this home to spread on pancakes as had been done when molasses had been used. Later it was found that some roads with a certain kind of clay were greatly benefited by sprinkling this liquor on them. The liquor seemed to form with the colloidal clay a mixture or compound that was coherent and laid the dust and provided a hard surface which was unexpectedly water resistant and was therefore quite permanent.

Later, improvements were made by adding alum and thus removing the lime which existed as a sulphonic compound and substituting alumina which enabled it to be used as a tanning agent. This proved the most important field but since the amount of solids dissolved from the wood is about equal to the amount of pulp produced it is evident that the tanning industry could not consume all of this residue. Many efforts are still being made to evaporate sulphite liquor with the requisite number of multiple effects in series to make it profitable or at least reduce the quantity of heat required to a point at which the solids may, by their own combustion, furnish enough heat to do the necessary evaporating. Not enough progress has been made to date in multiple effects construction and operation to make this profitable and stream pollution from sulfite pulp plants remains a serious problem.

Inorganic compounds are also made from wastes from some processes. These compounds are soluble and usually of such little value that their sale will not pay for evaporation to dryness. By developing uses for the products they have been made to pay as by-products in some instances. As examples, it may be said that the salt brines of the Ohio River valley which are extensively worked at Pomeroy, Ohio, and of late at and near Charleston, West Virginia, and also in Oklahoma in connection with oil production contain about 20 per cent of their solids as magnesia and calcium chlorides. Bromine was extracted from the Ohio river brines more than a generation ago and for many years bromine has been produced from the Michigan brines. With high prices for bromine even the salt is an undesirable product but it must be kept out of the streams and rivers.

At Midland, Mich., processes have been perfected for evaporating this brine and salting out the sodium chloride in vacuum pans operated with exhaust steam which has been brought down to 24 in. vacuum in steam engines generating electric current. Now one pound of coal will furnish enough steam and heat to generate enough current to electrolyze a pound of salt to caustic soda and chlorine and yet furnish exhaust enough to evaporate the salt from the brine. This method has required long periods of study, work and thought and ingenuity enough to so correlate the process as to utilize all the brine products and eliminate all stream pollution.

Before prohibition most of the whisky distilling was done in the Ohio valley or other tributaries of the Mississippi and the residual slop was poured into the streams. With increases of plant size the nuisance became so great that the farmers sued the distillers for poisoning cattle that drank the water, the fish commission objected to the destruction of fish and their eggs and finally the Federal government declared it a nuisance to discharge the slop into navigable water. As so frequently hap-

pens chemical improvements were tried, not so much to produce profits, but to avoid penalty under court injunctions.

An investigation of this problem showed that a bushel of corn was made into about 45 gal. of mash. Distillation of this produced about 55 gal. of "slop" on account of the dilution by the live steam led into the still in distilling off the alcohol. The total solids left after the alcohol was removed were about 22 lb. of which about 9 lb. were particles of bran and other insolubles which could be, and in many cases were, removed by filtering or screening. Drying of this material produced distillers' grains which, like brewers' grain, were recognized as a valuable stock food stuff.

The filtered liquid was a creamy viscous fluid with solids in colloidal solution as well as slimy yeast residues. The evaporation of this liquid which contained about ten pounds of possible cattle food in a barrel of water appeared to be a hopeless task but by proper design of the multiple effect evaporator it was brought to a heavy sludge which was sprinkled on once dried grains which were redried after the liquid had soaked into them. On redrying their weight was increased to double what they were before and the whole mess constituted as good cattle food as the grains alone.

The first distillers who put this system in were appalled at the price of the copper apparatus necessary for concentrating the acid slop but they were compelled to put it in or discontinue manufacturing. After running the first season it was found that the profits were 33 per cent on the investment. This happy result was in part due to a system devised by which the spent slop was evaporated in an outside vessel with a "calandria" whereby the heating steam could be run back to the boilers and the vapors from the slop were used to run the "beer still." This resulted in a saving of 20 per cent on the total evaporation. Another saving was in taking a large part of the dilute slop from the still and after cooling it was "slopped back." That is, it was put into a subsequent fermenter. The acids in the slop made a solution which killed off bacteria and therefore stimulated the yeast and the dead yeast in the slop acted as a fertilizer for the growing yeast. As high a proportion as 50 per cent was slopped back reducing the evaporating cost by one half. This method has been used in the treatment of molasses alcohol distilleries; not for profit but as a matter of compulsion to avoid pollution of waters containing fish and oysters.

In the manufacture of corn starch and sugar and similar products it has been customary for a long time to evaporate the "steep water" and to dry the germs and to mix the two to produce a cattle food. This not only rids the streams of a nuisance but the value of products produced is greater than the cost of recovery, provided the proper attention is paid to economy by using multiple effect evaporation, preferably with exhaust steam. In the manufacture of the higher alcohols for solvents it appears that the residual "slop" from the process employing corn as the raw material must be eliminated some way without further polluting the streams. Evaporation is the only certain and tried way. The above examples of perfected processes are here cited to show the wide adaptability of the evaporation system for preventing stream pollution as well as eliminating nuisance. It is hoped that it will call attention to the low cost of the method when *properly adopted* and with the installation of proper apparatus for the special work of each problem.

The chemical engineer is necessarily a scavenger as only the waste products that can be treated in no other way for profit or which are nuisances are turned over to him after all other hope has faded. More money must be invested nowadays in economies produced by recovery of by-products as one step in eliminating nuisances and pollution of streams.

Multiple Effect Evaporators

Multiple effect evaporators are of various designs; depending on the liquid evaporated. The pattern most used consists of a set of vertical tubes surrounded by a casing forming the calendria. Above this is the boiling chamber in which the evolved steam is discharged.

In the bulbous type here shown, which is adapted to foamy liquids, there is above the legs a lower chamber filled with the liquid to be evaporated. This chamber receives a continuous input from the feed pump. Steam which may be about atmospheric pressure is let into the side of the calendria at "A" and surrounds the tubes in which the contained liquor boils and overflows the tubes shown in the third effect, liberating steam or vapor into a partial vacuum. The remaining liquid flows down the large outside tubes to the bottom and again is boiled in the tubes forming a rapidly circulating mass. The steam or vapor from the first effect passes through the neck down to the calendria of the second effect to the right and, being under a higher vacuum, the liquid in it will boil and the vapor passes into the calendria of the third effect, which being under the highest vacuum because it is nearest the vacuum pump, will boil at an even lower temperature. Thus the liquid in each effect boils and passes its latent heat to the liquor in the succeeding effect. One gallon of condensed steam in the calendria should boil off a gallon in each succeeding one, but usually a triple effect will boil off two and one-half gallons of water for each gallon of water condensed from the steam. Since this same steam may have been used previously for power production, the heat cost is very little.

Water Softening Results

The following table taken from a recently issued booklet by R. E. McDonnell, of Burns & McDonnell Engineering Co., Kansas City, Mo., gives results in some cities that are operating water-softening plants:

Location	Hardness Raw Water (p. p. m.)	Hardness After Treatment	Cost Per M. G. for Softening	Cost Per Thousand Gallons
Springfield, Ill.	230	82	$17.24	$0.0173
Columbus, Ohio	...	...	17.52	.0175
St. Louis, Mo.	190	102	2.21	.0022
Cedar Rapids, Iowa	240	80	8.00	.0080
Vermilion, S. D.	670	145	50.00	.0500
Daytona Beach, Fla.	368	99	9.63	.0096
Austin, Texas	225	85	5.00	.0050
Lawrence, Kas.	220	77	15.00	.0150
Mangum, Okla.*	545	85	42.00	.0420
Piqua, Ohio	204	68	10.20	.0102
Huntsville, Texas*	340	0	40.00	.0400
Benton Harbor, Mich.	255	128	28.00	.0280
Independence, Kas.	238	152	2.50	.0025
Newark, Ohio	255	68	13.00†	.0130†
Kent City, Ohio	221	68	16.57†	.0166†
Liberty, Mo.	417	136	17.00†	.0170†
Miami, Fla.	250	45	57.65‡	.0576‡
Bloomington, Ill.	230	80	3.50	.0035
Granville, Ohio	285	85	13.90	.0139
Abilene, Texas	170	50	6.00	.0060
Sewickley, Pa.	180	50	40.45	.0405
Iola, Kas.	289	163	11.03	.0110
Marion, Ohio	741	139	60.00	.0600
Beverly Hills, Calif.	242	147	24.17	.0242

*Zeolite plants.
†Cost of chemicals only.
‡Total cost including pumping, depreciation, interest, etc.

THE ECONOMIC REPLACEMENT OF PUMPING EQUIPMENT*

H. P. BINDER

Engineer, Allis-Chalmers Mfg. Co.

PRESENT business conditions offer a wonderful opportunity for municipalities to attain the maximum available in economy with the least cost. This is a so-called buyers' market and present pumping machinery prices are from 20 to 25 per cent below prices of the predepression period and power companies are seeking additional power loads of the desirable sort such as is required by pumping stations.

Communities are spending much money for relief from which there will be no future financial return and some of this might well be put into reconstruction projects from which future economic improvement would result.

In practically all places there is a demand from taxpayers for greater economy. In addition to reducing salaries and wages, more consideration should be given to the purchase of modern and improved equipment in order to save money which is now going to waste in operating or repairing obsolete equipment.

In general, pumping plants are only improved when cities grow rapidly and additional pump capacity is imperative, or when machinery is worn out and major breakdowns mean expensive repairs. When this time comes, the machinery has long passed its economic usefulness. Pumping plants that are kept up-to-date seldom replace their machinery because it is worn out, but because it has become obsolete or non-economical to operate. Steam and power pumps have not been radically improved during the last twenty years, and air lift pumping has never been highly efficient. On the other hand, centrifugal pumps have been materially increased in efficiency and in their adaptability to municipal service. Centrifugal pumps have been increased from 5 to 8 per cent in efficiency since 1924 and from 10 to 15 per cent since 1914. This has been due to extensive shop testing and development by the manufacturers and the keen competition of the various companies building pumps. It was accomplished by better hydraulic design of runners and casings. Higher speeds have also contributed to this improvement. Practically none of it can be attributed to mechanical features such as closer clearances, difficult to maintain. In other words, the improvements shown have been due to designs which maintain their values and are not easily lost by wear.

There has been a decided trend in the pumping situation over practically the whole country. Before the year 1915, pumping engines were supreme in this field and there are many fine engines to be found, which were installed in this period, and which are still giving very good service. For the next twelve years, in the period from 1915 to 1927, there was a decided trend from those pumping engines to steam turbine reduction gear driven centrifugal pumps. Since the year 1927 there has been a decided trend toward electrically driven units, even in the very large sizes, which began earlier in the small units field.

There are several reasons for the above changes in pumping station practice, the principal one of which is the total cost. There is a ratio of costs required covering the complete station, of about 1:5:15 for electrical driven centrifugals, steam turbine gear driven centrifugals, and vertical triple pumping engines respectively. This ratio, of course, is for new development, taking into account the cost of the pumping units, foundations and buildings, and boiler and coal handling equipment. In some instances the lower priced equipment was made necessary in rapidly growing cities, where the limitation of bonded indebtedness had been reached, and money could not be raised for putting in the more expensive though more favored machinery.

Another important factor that entered into this problem was the improvement of the electric current supply. Lower rates became effective and multiple sources of power to insure reliability of service become available. In some communities the increased influence of the public service companies had its effect.

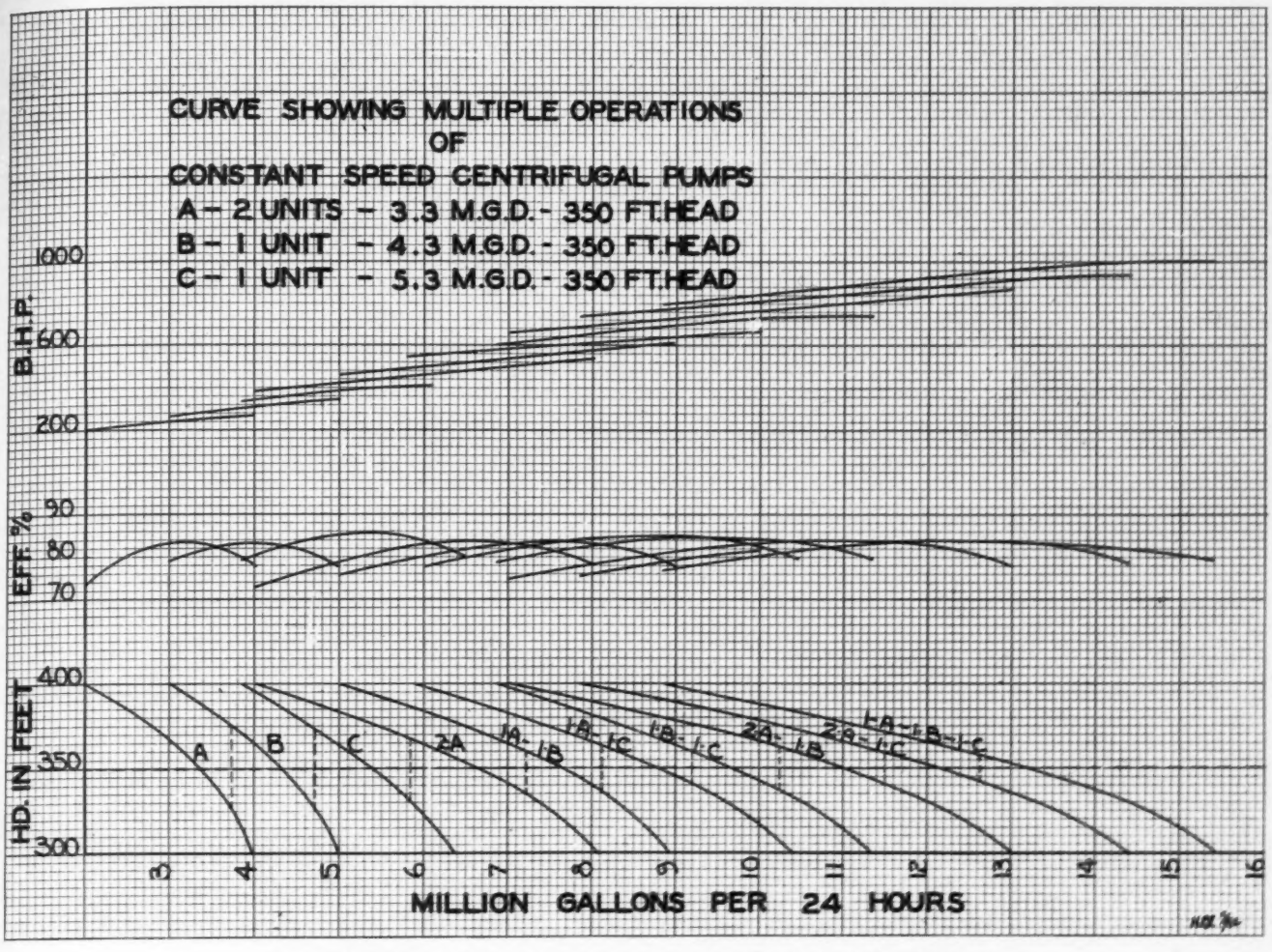
Fuel costs have not increased to the extent where the high operating efficiency of the triple expansion pumping engine can justify this most expensive of all of the installations. There will probably never be another large triple expansion pumping engine built and installed, even though there are record duties reaching 210 million foot pounds per thousand pounds of steam. Turbine gear driven centrifugal pumping units were rapidly improved in their economies both on the steam turbine and centrifugal pump end, and practically eliminated the pumping engine. Duties on this type of unit reach within 10 per cent of the pumping engines under the same steam conditions, and, furthermore, enable cities to install much larger capacities in much smaller spaces. The unit of 60 million gallons per day capacity against 300 ft. head as recently installed in Milwaukee, reached an official test duty exceeding 195 million foot pounds per thousand pounds of steam.

Synchronous motor driven pumping units are now making rapid strides to supplant the turbine gear driven units on new installations and more particularly in large city booster stations. The City of Pittsburgh put its new Brilliant pumping station into operation this summer in which the 28 million gallon per day motor driven units at 365 ft. head, driven by 2,250 HP. motors, showed an average overall wire to water efficiency amounting to 87.50 per cent.

With electric drive the difficult problem to overcome is that practically all installations must utilize alternating current, and unfortunately there is no economical variable speed type of motor drive to apply on municipal work to obtain constant head with variable capacity of demand. Where elevated storage exists beyond the pumps, variable speed is not required and electric drive is, therefore, easily adapted.

On closed systems, however, more study is required. Where cities desire to increase pressures, as rates of consumption increase, it is even more difficult. Where the pressure, however, can be maintained constant, or within narrow limits, the best practice is to apply several pumps of different capacity ratings and operate them in multiple combinations over the range of best efficiency at constant speed. On units requiring around 200 HP. and up, this permits the use of synchronous motors with

*Excerpts from a paper read before the Wisconsin Section of the A. W. W. A., at Appleton, Wisc.



Curve Showing Multiple Operation of Constant Speed Centrifugal Pumps

higher efficiencies and without increase in first cost above that for induction motors.

The curve accompanying this article illustrates the scheme of multiple operation. Four units have been selected, two designated as "A" rated as 3.3 in m.g.d.; one 4.3 m.g.d. unit designated as "B," and one 5.3 m.g.d. unit designated as "C." All these are rated at 350 feet of head or 150 lbs. pressure. You will note from this curve that at low capacities one unit is operated and the maximum head range does not vary more than 20 lbs. As we get out to the maximum capacity, this range can be maintained within about 7 lbs. limitation. These four units permit a total capacity range from 2.75 million gallons per day up to 14.5 million gallons per day within the 20 lb. head range, which is only slightly more than 13 per cent of the total average head. This is accomplished with only three of the four units in operation, leaving one as a spare.

The pump efficiencies are maintained at a high value, not dropping below 80 per cent pump efficiency at any point within this extreme range, and likewise a fairly even slope to the power curve is maintained. The motor efficiencies vary but slightly and, therefore, the kilowatt input will follow practically parallel to the brake horsepower curves shown.

In large stations requiring 15 or 20 m.g.d. units or larger, steam stations may still prove economical provided close surveillance of all equipment from the coal pile through the stokers, boilers, accessories, and the pumping unit is practiced to maintain the complete station at good operating economy. This requires a thorough and comprehensive daily log system in preference to a periodical duty test. Supplementing this daily log system, intelligent and immediate attention must be given to any indication of falling economy.* Electrical stations are not nearly so exacting in this regard, as there are not so many possibilities of lost efficiency. Furthermore, electrical stations are easily adaptable to automatic operation and, therefore, reduce operating personnel expense.

For several of the above reasons electrical driven centrifugal deep well pumps are taking the place of the air lift and displacement type of deep well pump. An example of results obtained on a small installation is found at the plant at Mukwonago, Wisc., where the old air lift pumping equipment was replaced by a motor driven centrifugal deep well pump, increasing the pumping capacity from 70 gallons per minute to 150 gallons per minute, with a corresponding increase in the drawdown and consequent higher pumping lift. Even with these increases in capacity and head they report a decrease in power cost from $589.72 to $402.11 for a pumpage of roughly 5.5 million gallons, or a difference of $34.10 per million gallons pumped. This is a decrease of over 30 per cent and without further calculation it is apparent that at this rate the new equipment will pay for itself in a very short time.

Another striking example of the possibilities of improving economy is shown in the motor driven installation at the City of Viroqua, Wisc., where a 500 gallon per minute motor driven deep well pump replaced an

*The reader is referred to a valuable article, "Pumping Plant Economies," by L. A. Jackson, in WATER WORKS AND SEWERAGE for October, 1922, which deals with steam operated pumping stations practices leading to economies.

air lift system of approximately the same size. They report for the year 1924 with the old system a total pumpage of 66,289,650 gallons with a total power cost of $5,528.75 or 8.35 cents per thousand gallons. In the year 1931 with the new equipment, they pumped 72,059,650 gallons with a total pump cost of $3,431.12 or a rate of 4.75 cents per thousand gallons. These figures show a reduction of 43 per cent in the unit cost of power alone, and in addition to this, one pump operator was eliminated by using automatic operation.

In distribution systems there are just as remarkable examples as indicated above. The City of Ironwood, Mich., installed a 5x4-inch four-stage, double-suction type centrifugal unit rated at 900 gallons per minute against 630 feet of total head, driven by a 200 HP., 1,760 r.p.m., slip-ring motor to replace old pump equipment. They report a total pumpage of 388,260,000 gallons from March, 1928, to March, 1929, for a power cost of $27,747.70 or at a unit rate of 6.88 cents per thousand gallons. With the new equipment, from March, 1929, to March, 1930, they pumped a total of 390,646,000 gallons at a power cost of $17,955.75, thus reducing the unit rate to 4.55 cents per thousand gallons. This represented a saving of $9,791.95 in the power cost and a 34 per cent reduction in the unit rate. The purchase price of the new equipment was $3,250 and their installation expense was $1,450, making a total of $4,700. This shows that the new installation was paid for by power cost alone in six months and left them slightly over $5,000 "profit" in one year.

At the City of Waycross, Ga., an old steam plant was replaced. The original plant had steam driven air compressors with air lift on their wells and one two million gallon per day and one three million gallon per day tandem compound pumping engines for distribution. The new motor driven centrifugal deep well pumps deliver about three million gallons per day. Three two million gallon per day (140 ft. head) centrifugal distribution pumping units were installed occupying one-twentieth of the floor space of the old steam equipment. The entire operating cost per thousand gallons averaged 5.25 cents for the last three years that the old plant operated, and this was reduced to 3.627 cents per thousand gallons with the new equipment. This represents a saving of 31 per cent on the unit rate, and their reports show a total saving for one year of $5,902.31 on a capital investment of new equipment of about $12,000. In addition to this, they have more available pumping capacity with the new equipment than formerly.

The above examples illustrate the possibilities that must exist in many plants over the country. Some operators and superintendents seem to lack realization that their pumping equipment slowly becomes obsolete before it actually is worn out. Others, while perhaps appreciating this fact, do not determine what to do. They do not make the effort to work out the details of proof to convince the governing officials that replacements of old equipment would prove economical.

When a superintendent makes a study of operating costs and compares them with the previous years, it would be a good practice for him to take inventory once a year and satisfy himself whether the economy can be improved even though the plant equipment seems to be operating satisfactorily. It is not necessary for him to go to the expense of employing consulting engineers for this periodical check-up. A letter to two or three reputable pump builders stating the capacity, head, power characteristics, and total quantity pumped, power rate and the unit cost of power per thousand or million gallons per day will give sufficient data on which to make a decision as to whether or not they might suggest replacements which would result in a saving to the city. Such a procedure would keep the superintendent up-to-date on the advances being made in pumping equipment, if nothing more.

Where complete studies are needed in connection with new projects, for radical or extensive improvements, or for accurate comparisons of abnormal conditions, the services of reputable consulting engineers are required. The manufacturer does not and should not endeavor to cover this field of the consulting engineer, and frequently is able, from preliminary investigations, to determine whether or not consulting services are required or justified.

▼

Severe Sewer Explosions in Montreal

A series of sewer explosions occurred in the St. Dennis' Boulevard section of Montreal on November 30 which injured twelve persons—none very seriously, however. The heaviest explosion crumbled a block of three-story dwellings, according to news dispatches. Manhole covers flew high into the air, flames burst forth and miles of streets were torn up by the blast. One mile away from the center of the explosion a gasoline filling station blew up. Two miles further away manholes were shot skyward as the explosion spread through the sewers and broke out window panes. Heat in the district was intense and for three hours repeated blasts were heard.

The cause of the explosion had not been determined at this writing but the theory advanced is that the presence of flamable liquid, probably gasoline, in the sewer started the trouble and that the first blast possibly broke a gas main and resulted in continued burning interspersed with explosions.

▼

Iron Soft as Copper

Highly purified iron, possessing many of the qualities of copper, has been prepared in Germany by a new process described recently by Dr. L. Schlecht. Carbon monoxide of a high degree of purity is passed over hot iron previously purified by ordinary methods, forming liquid iron carbonyl. On heating this liquid, carbon and oxygen are driven off, leaving iron in an exceedingly finely powdered form with hardly a trace of impurities. The individual spherical particles are 20-millionths of an inch in diameter. When this powder is heated still further to a temperature of 1200 degrees Centigrade, it changes into solid iron that resembles copper in its softness, resistance to corrosion, and other properties. The process is declared to be applicable on a large scale. —"The Valve World," October 1932.

▼

Long Island Communities Have New Sewage Plant Laboratories

The sewage treatment works at Huntington, Suffolk county, and at Atlantic Beach, Nassau county, New York, have been equipped recently with laboratories for plant control and efficiency. These installations will permit daily bacteriological examinations of the sewage effluent which will be of utmost importance since the effluent of both plants is discharged into waters used for recreational purposes. A laboratory is practically essential in the operation and control of modern sewage treatment works. Other municipalities would do well to make similar installations.

Aerial View Treatment Plant, High Point, N. C.

SEWAGE TREATMENT AT HIGH POINT, N. C.

E. H. MOSS[1] and C. W. MENGEL[2]

THE City of High Point, North Carolina, lies on a ridge separating the watersheds of Deep River and Yadkin River. Approximately two-thirds of the area inside the city limits drains naturally into Deep River or its tributaries, and one-third into tributaries of the Yadkin River.

Prior to 1930, four pumping stations picked up that part of the sewage not directly tributary to Richland Creek, a Deep River tributary, and pumped it to a trunk line sewer located along that creek, which sewer discharged into a two story tank on the eastern edge of the city. This tank which was built in 1919 was the only treatment works afforded until June, 1929.

Due to the rapid growth of High Point during the past decade, the existing treatment plant became wholly inadequate, and in 1927 plans were made to replace it with an adequate modern treatment plant. This plant was placed in operation, June, 1929, and is known as the East Sewage Treatment Plant. It was apparent, soon thereafter, on account of the spread westward of the residential section of the city, that either two of the westerly pumping plants would have to be rebuilt further downstream, and new lines constructed to and from them, with the addition of new pumping equipment, or a treatment plant would have to be constructed at the convergence of all the small streams heading in that area. The governing body of the city decided to build a treatment plant which was completed in October, 1930. This plant is known as the West Sewage Treatment Plant.

East Sewage Treatment Plant

Approximately 25,000 population is now served by the East Plant. In addition to the domestic flow from this source, there are also tributary to this plant more than twenty furniture manufacturing plants, veneer plants and more than thirty-five textile establishments consisting of cotton yarn mills, silk mills, hosiery mills and cotton cloth mills. The industrial wastes from these plants which represents more than 20 percent of the total flow, are discharged into the sewer without regulation as to the rate of flow or time of application. Because of the make-up of the sewage, and on account of the fact that the effluent from the proposed plant would be diluted by the flow in Deep River a half mile below the site, and further on account of the sparsely settled community around the site, plans were made for treatment by a plant of the separate sludge digestion-trickling filter type. By extending the old outfall for five miles, an ideal site was found for the erection of the plant, where all operations would be by gravity, other than the pumping of sludge from the final settling tanks. The outfall sewer serving this plant has a capacity of ten million gallons per day and is laid on a sustained gradient of 0.18 percent. Eighteen trestles varying in height from six to forty feet, and two inverted siphons constitute a part of this sewer outfall. The plant was constructed with a capacity of 4,800,000 gallons per day, normal dry weather flow. Ample room is afforded at the site for doubling the capacity, if found necessary at a later date.

The units composing this plant, in order of their use, together with other pertinent data concerning them are here given:

1. **Diversion Manhole**—Gates manually operated.
2. **Screen Chamber**—Bar screens, hand cleaned; spacing of bars 1¼ ins.
3. **Detritor**—Dorr type, dimensions 12 ft. by 14 ft.
4. **Operating House**—Contains switching equipment, refrigerator, chlorinating equipment for treating the crude sewage and 30 ins. by 12 ins. Venturi meter and register.
5. **Primary Settling Basin**—Link-Belt type, battery of four in one, uncovered; detention period full flow, 1 hr. 37 min.; scum baffle and trough provided for flushing scum into digester; effluent, or entire contents of the tank can be drained and by-passed if necessary, by gravity; sludge flows to digesters by gravity.
6. **Dosing Tanks**—Concrete construction, equipped with Pacific flush tank, deep bell twin siphon, alternating.
7. **Trickling Filters**—Dimensions over-all 503 ft. by 225 ft., divided into three equal areas; walls, outside and division of concrete; inspection galleries, with openings for flushing, provided; filter material, granite; grading of bottom foot, 2½ ins. 4 ins., top 6½ ft., 1½ ins. to 2½ ins.; Metro under-drainage system; nozzles ⅞ in., 14 ft. 6 ins. on centers; effluent can be by-passed without passing through secondary tanks, if necessary.

In this article the authors have presented a brief description of two sewage treatment plants serving the City of High Point, N. C.

The older plant is of the sprinkling filter-separate sludge digestion type. It receives sewage highly impregnated with spent dyes and other textile manufacturing wastes. The new plant is of the activated sludge type and receives sewage of domestic origin only.

Operating results and cost data have been carefully kept for the purpose of comparing efficiencies, dependability and operating costs. These illuminating data are presented here for the purpose of informing engineers and municipal officials as to accomplishments and treatment costs of the two processes.—Editor.

[1]Superintendent of Water and Sewage Treatment Plants, High Point, N. C.

[2]Engineer, Wm. C. Olsen, Consulting Engineer, Raleigh, N. C.

8. **Secondary Tanks**—Link-Belt type; battery of four in one; detention period full flow, 45 min.
9. **Effluent**—To creek, without further treatment.
10. **Digesters**—Two; each digester has two separate sections, each section having a common compartment 10 ft. in depth at the bottom of which are three hoppers, 12 ft. in depth; two sludge outlets for each hopper, one at bottom, and one at top, 12 ft. up; piping system for heating; sludge circulating piping, whereby sludge can be taken from any compartment and transferred to any other compartment; gas collecting apparatus; sampling holes; total volume, 87,360 cu. ft.; sludge flows to drying beds by gravity.
11. **Sludge Conditioning House**—Equipped with vertical sludge circulating pump, dry feed machine for lime, gas heater connected to hot water pump and circulating system; recording thermometers for sludge and circulating water temperature.
12. **Supernatant Collector**—Covered concrete basin arconnects to line leading back to primary settling tanks; ranged for lime dosing, if necessary; vertical sewage pump emergency gravity line to part of sludge beds.
13. **Sludge Drying Beds**—Area 40,000 sq. ft., divided into eight sections, each 50 ft. by 100 ft.; outside walls, division walls and bottom of concrete; under-drainage system of tile covered by stone and sand filter; sludge collected when dry by industrial railway; water drains to creek by gravity.
14. **Humus Sludge Pump House**—Concrete and brick structure housing horizontal sludge pump for removing humus from final settling tanks; discharge lines to either the digesters or to sludge beds.
15. **Water Supply**—Water pumped to elevated tank; 4 in. distribution system with hydrants distributed at points convenient for use in cleaning.
16. **Cost**—The cost of the plant including cost of land and engineering was $465,000.00.

West Sewage Treatment Plant

This plant handles the sewage from approximately 10,000 people. With the exception of some laundry waste, the sewage is entirely domestic.

On account of the flat valley through which the outfall sewer to this plant passes, a high line sewer was not practicable. Therefore, all sewage reaching this plant must be pumped. The stream into which the effluent discharges runs dry some time during each year, and at no time would the dilution be great. Because of this and also because some neighboring towns had lost suits when emptying trickling filter effluent into small streams, it was decided to design and construct a plant of the activated sludge type. The location is such that it can be enlarged indefinitely on the same site by the addition of any number of like units. Design capacity is two million gallon per day normal flow.

The units composing this plant, in order of their use, together with data pertinent thereto, are here given:

1. **Diversion Manhole**—Equipped with valves for manual operation.
2. **Screen Chamber**—Concrete, with twin parallel chambers, used alternately as desired; bar type screens, with ¾ in. clear opening between bars; rakes are power driven.
3. **Detritor**—Dorr type; space is provided after effluent passes detritor for entrance of gravity line carrying return sludge. This method of sludge return is used perhaps 90 percent of the time.
4. **Receiving Well**—For raw sewage; lifted from this well for travel through the plant.
5. **Mixing Chamber**—Open concrete structure, baffled vertically; air lift from one sludge return line enters here, use optional; auxiliary return sludge line from centrifugal pump enters here, use optional.
6. **Aeration Tanks**—Two concrete tanks, each 15 ft. by 240 ft., depth of flow, 12 ft., spiral flow type with two rows of filtros plates on bottom of the tank next to common wall dividing the two tanks; Y shaped baffles built into structure.
7. **Settling Tanks**—Link-Belt type; two units, each 15 ft. by 68 ft., depth of flow 12 ft.; wire plates of brass, sawtooth design.
8. **Effluent**—By gravity to creek.
9. **Operating Building—Center Basement** contains the three sewage pumps and the heating plant.

Center Ground Floor houses the following equipment: lighting panel; electric valve panel; manometers and register recorders for both air and sewage; main switchboard controlling 110 volts, 220 volts and 2300 volts circuits, with voltmeters, ammeters and recording watt-hour meters; 3 motors of 15 hp., 20 hp., and 25 hp., 220 volts, vertical, driving the 700 g.p.m., 1050 g.p.m., and 1400 g.p.m. crude sewage pumps. Each pump operates in four stages, the operation being automatically controlled by the depth of sewage in the receiving well.

Center Second Floor contains the office, store room, lavatory and shower and a small laboratory.

Center Third Floor is used for chemical storage. Monorail hoist on this floor loads from outside the building.

Right Wing houses the three air compressors. These each deliver 1500 cu. ft. per minute at 8 lb. Also housed in this wing are one variable type speed auxiliary sludge pump and one pressure type water filter.

Left Wing houses the sludge filtering equipment consisting of two Oliver vacuum filters each 5 ft. 8 ins. by 8 ft. 0 in., with the necessary vacuum pumps, sludge pumps, filtrate pumps, conditioning tanks and other appurtenances.

10. **Sludge Storage**—One tank on outside filter room, fitted with air connection, and two filtros plates.
11. **Water System**—Consisting of one 50 g.p.m. water pump, pressure filter, elevated tank, and distribution system with hydrants at points convenient for washing.
12. **Electrical Substation**—With transformers to step down from 13,200 volts to 2300, 220 and 110 volts.

The total cost of this plant, including cost of land and engineering was $235,000.00.

The operation of both plants is under the supervision of the superintendent of plants, who reports to the director of public utilities. The superintendent of plants has

West Treatment Plant, High Point, North Carolina.

TABLE I—OPERATING AND ANALYTICAL DATA, EAST PLANT (Sprinkling-Filters)

	Dec. 1929	Jan. 1930	Feb. 1930	Mar. 1930	Apr. 1930	May 1930	June 1930	July 1930	Aug. 1930	Sept. 1930	Oct. 1930	Nov. 1930	Total	Av.	Max.	Min.
Flow: M.G.D.	2 720	2.170	2 055	1.795	2.120	2.430	2.350	2.390	2.220	2.983	2.883	3.048	29.164	2.430	3.048	1.795
Screenings: C.F.M.G.	.5	1.0	1.4	1.3	1.1	1.1	.9	1.2	1.0	1.0	.7	.7	11.9	1.0	1.4	.5
Grit: C.F.M.G.	....	....	....	....	5.2	3.7	4.0	5.6	6.7	3.0	2.0	1.0	31.2	3.9	6.7	1.0
Digested sludge drawn C.F.D.	161	470	534	654	833	645	333	968	0	333	0	167	5,098	425	968	0
Dry sludge removed C.F.D.	0	54	208	346	333	322	200	258	258	0	0	0	1,979	165	364	0
Gas produced 1000 C.F.D.	10.80	11.05	10.65	12.00	11.60	7.34	7.88	6 55	5.00	5.87	3.84	2.60	89.897	7.491	12.00	.587
Temperature air °C.	6	7	9	8	15	21	22	25	24	23	14	9	183	15.2	25	6
Temperature raw sewage °C	17	16	16	15	20	24	25	28	28	28	25	20	262	21.8	28	15
Temperature tank sludge °C	22	22	21	23	26	27	28	29	31	29	28	21	307	26	31	21
Rainfall, inches	3.15	4.45	1.71	2.26	1.31	3.90	3.89	5.67	1.72	2.96	5.39	4.10	40.51	3.38	5.67	1.31
Lime for sludge conditioning P.P.D.	25	0	78	13	40	30	0	39	26	0	0	60	311	26	78	0
Cost $ per M.G.	9.89	13 50	13.75	16.20	23.00	9.51	11.58	10.09	13.90	16.95	26.50	6.75	171.62	14.30	26.50	6.75
Per cent removal suspended solids—tank	47.0	45.2	41.2	54.5	48.8	56.0	7.02	60.9	52.7	50.1	56.0	42.2	624.8	52.1	70.2	41.2
Per cent removal settleable solids—tank	65.0	64 8	61.8	70.6	67.4	76.5	79.5	75.8	65.5	62.1	73.9	59.2	821.6	68.5	79.5	59.2
Removal suspended solids—plant	73.2	68.2	80 1	89.0	82.0	90.6	96.3	89.6	93.1	91 8	90.2	83.1	1027.2	85.6	96.3	68.2
Per cent B.O.D. reduction—plant	90.4	90.2	90.7	90.9	93.1	94 3	95.2	96.2	97.4	96.5	92.8	91.6	1119.3	93.3	97.4	90.2
Organic nitrogen, settled*	8.19	9.52	12.88	10.12	9 35	9.72	10.29	11.35	....	....	....	....	81.42	10.17	12.88	8.19
Organic nitrogen, filtered*	4.84	5 27	4.76	5.82	8.01	5.15	4.81	5.50	....	....	....	....	44.16	5.52	8.01	4.76
Ammonia nitrogen, settled*	12.92	12.78	12 56	18 70	24.00	21.62	18.95	13.54	....	....	....	....	135.07	16.88	24.00	12.56
Ammonia nitrogen, filtered*	.55	3.30	4.36	3.42	4.54	4.99	1.14	.05	....	....	....	....	22.35	2.79	4.99	.05
Total solids—raw*	546	608	567	666	673	786	779	828	893	866	891	753	8856	738	893	546
Total solids—settled*	399	439	438	486	482	540	595	590	702	738	755	675	6837	569	755	399
Total solids—filtered*	433	456	438	493	602	580	550	593	642	671	726	698	6882	573	726	433
Total solids—final*	374	422	387	412	470	514	506	520	596	633	699	636	6169	514	699	374
Suspended solids—raw*	164	188	170	224	212	245	255	285	275	254	234	185	2691	224	285	164
Suspended solids—settled*	86	103	100	102	107	107	108	115	130	115	101	102	1276	106	130	86
Suspended solids—filtered*	87	103	80	82	188	88	57	43	61	41	60	106	996	83	188	41
Suspended solids—final*	44	60	33	26	35	23	18	15	18	18	21	24	335	28	60	15
B.O.D. 5 DC 20°C—raw*	314	334	301	375	391	500	437	342	342	288	306	369	4299	358	500	288
B.O.D. 5 DC 20°C—settled*	198	187	170	289	228	262	295	218	214	208	229	279	2777	231	295	170
B.O.D. 5 DC 20°C—filtered*	38	45	35	46	52	46	34	17	14	15	31	53	426	35	53	14
B.O.D. 5 DC 20°C—final*	30	33	28	34	27	28	21	13	9	10	22	31	286	24	34	9
B.O.D. 5 DC 20°C—stream "A"*	8	8	7	9	7	12	13	9	7	8	6	9	103	9	13	6
B.O.D. 5 DC 20°C—stream "B"*	42	20	17	20	18	20	22	21	8	9	14	21	232	19	42	8
Dissolved O_2—raw*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dissolved O_2—final*	8.0	8.0	6.2	6.2	5 5	4.3	2.7	3.2	2.8	2.0	3.2	5.3	57.4	4 8	8.0	2.0
Dissolved O_2—stream "A"*	10.2	11.4	10.5	10.5	9.1	9.1	7.6	6.6	7.4	7.5	8.2	9.7	107.8	9.0	11.4	6.6
Dissolved O_2—stream "B"*	9.0	10.3	9 3	9.3	8.1	8.2	6.3	5.6	5.5	5.3	5.6	7.4	89.9	7.5	10.3	5.3
Filtered nitrates and nitrites*	5.34	5.09	5.85	7.32	10.85	15.05	11.93	7.90	9.79	7.89	7.22	7.42	101.65	8.47	15.05	5.09
*Parts per million.																
Per cent solids, fresh sludge	6.0	....	....	8.0	....	....	5.6	....	5.5	8.0	....	....				
Per cent solids, tank sludge	11.7	10.5	10.6	....	10.5	9.5	15.0	9.0	8.5	9.6	....	8.2				
Per cent solids Organic, fresh sludge	38.4	....	....	78.7	85.0	....	69.2	....	71 6	65.0	....	....				
Per cent solids Organic, tank sludge	34 7	36 0	33.5	....	35.2	39.8	41.7	58.5	41.9	34.8	....	47.4				
Per cent ash, fresh sludge	61.6	....	....	21.3	15.0	....	30.8	....	28.4	35.0	....	....				
Per cent ash, tank sludge	65.3	64.0	66.5	....	64 8	60.2	58 3	41.5	58.1	65.2	....	52.6				
Ph—tank sludge	7.0	7.0	7.3	6 9	7.5	7.3	7.5	6.6	6.8	7.3	....	6.7				

charge of the two sewage treatment plants, the water pumping and filtration plant and two crude sewage pumping stations. The operating personnel may be divided into two parts; first, that portion of the personnel available for use at all plants; second, the portion permanently assigned to the individual plants. The first, or that available for duty at all plants, and whose time is charged to each unit according to the time spent on that unit, is as follows:

a. Technician, who divides his time between water analyses and routine tests for the two sewage treatment plants.

b. Mechanic, available where needed.

c. Floating labor gang, four men, whose duties are multitudinous and varied.

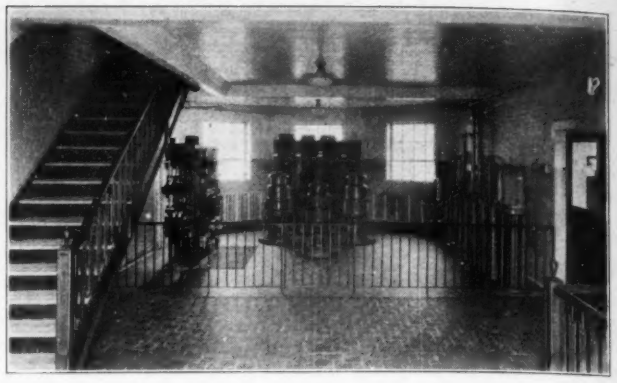
The East Treatment Plant (separate sludge digestion-trickling filter) is manned as follows:

1 Chief operator (white), day duty.
1 helper (colored), day duty.
1 helper (colored), night duty.

During the past year, when a reduction of expenses was made mandatory in the Division of Plants, the chief operator of this plant has taken a shift two days during each week at the West Treatment Plant.

The operating force for the West Treatment Plant (activated sludge) is:

1 chief operator (white), 12 hour shift, 11 to 11, five days per week.
1 operator (white), 12 hour shift, 11 to 11, five days per week.
1 helper (colored), day shift, seven days per week.



View Showing Pump Motor, Switchboards and Manometers—West Treatment Plant.

Two days per week, the plant is operated by the mechanic and the chief operator of the East Treatment Plant. Originally, this West Treatment Plant was operated by three men on eight hour shifts, which will undoubtedly become normal operating routine as soon as conditions permit.

Operating Routine

East Treatment Plant.—Screenings are removed hourly, deposited in a container, and buried daily.

Grit is removed from the detritor and spread on the ground daily.

Sludge from the primary settling tanks is drawn twice

TABLE II—OPERATING AND ANALYTICAL DATA, WEST PLANT (Activated Sludge)

	Nov. 1931	Dec. 1931	Jan. 1932	Feb. 1932	Mar. 1932	Apr. 1932	May 1932	June 1932	July 1932	Aug. 1932	Sept. 1932	Oct. 1932	Total	Av.	Max.	Min.
Flow: M.G.D.	.715	.940	1.021	.922	1.285	1.641	1.492	1.192	1.184	1.335	1.049	.758	13.514	1.125	1.641	.715
Operating cost $ M.G.	72.90	58.20	65.70	77.10	42.90	31.18	32.80	39.75	45.10	35.20	32.20	31.40	564.43	46.95	77.10	31.18
Total solids, raw P.P.M.	472	368	355	416	378	337	400	473	505	458	....	....	4162	416	505	355
Total solids, final P.P.M.	274	244	225	265	256	205	230	276	247	265	....	....	2487	249	276	205
Susp. solids, raw P.P.M.	218	155	133	153	126	106	148	174	195	167	184	176	1935	161	218	106
Susp. solids, final R.P.M.	22	20	18	20	16	15	16	17	17	19	19	13	212	18	22	13
B.O.D. 5 day @ 20°C raw P.P.M.	257	197	153	174	153	121	153	218	209	175	208	256	2274	190	257	121
B.O.D. 5 day @ 20°C final P.P.M.	18	14	12	12	12	14	15	16	12	14	16	13	168	14	18	12
B.O.D. 5 day @ 20°C stream "A" P.P.M.	7	6	4	3	3	4	4	5	2	4	4	4	50	4	7	2
B.O.D. 5 day @ 20°C stream "B" P.P.M.	8	7	8	6	6	6	7	7	5	8	6	7	81	7	8	5
Dissolved O_2, raw P.P.M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dissolved O_2, final P.P.M.	3.5	4.5	5.4	4.6	3.7	3.7	2.3	1 8	1.9	2.2	1.7	2.1	37.4	3.1	5.4	1.7
Dissolved O_2, stream "A" P.P.M.	9 8	11.3	11.8	11.1	9.5	9.9	8.3	7.5	6.5	6.3	7.1	7.0	106.1	8.8	11.8	6.3
Dissolved O_2, stream "B" P.P.M.	8.7	9.5	9.7	8.7	8.1	8.0	6.5	6 1	5.8	5.7	5.7	6.3	88.8	7.4	9.7	5.7
Nitrates and nitrites, final P.P.M.	3.15	2.69	2.83	2.63	2.10	1.47	1.00	.79	.82	1.05	.80	3.05	22.10	1.86	3.17	.79
Organic nitrogen, raw P.P.M.	11.85	8.97	7.00	9.51	9.64	6.54	7.86	8 70	10.00	8.91	....	....	88.98	8.90	11 85	6.54
Organic nitrogen, final P.P.M.	3 33	2.74	3.46	3.71	4.94	2.73	3.43	3 35	2.53	3.92	....	....	34.14	3.41	4.94	2.53
Ammonia nitrogen, raw P.P.M.	9.99	8.54	9.87	9.52	9.40	7.93	6.15	6.73	5.71	4.83	....	....	78.67	7.87	9.99	4.83
Ammonia nitrogen, final P.P.M.	.61	.15	.11	.31	.39	.52	.64	.81	.68	.68	....	....	4.90	.49	.81	.11
Per cent solids, aeration tank, Vol.	18	21	20	26	25	22	19	19	15	15	15	19	234	19	26	15
Per cent dry solids, aeration tank	.97	.71	.70	.65	.44	.48	.45	.42	.38	.45	.27	.28	6 20	.52	.97	.27
C. F. Air, per gal. sewage	1 59	1.16	1.58	1.86	1.06	.67	.96	1.14	1.37	1.38	1.65	2.41	16.83	1.40	2.41	.67
Hours filter oper. P.D.	2.7	3.7	4.1	4.4	9.0	8.7	6.3	7.8	6.3	4.5	7.0	4.7	69.2	5.8	9.0	2.7
Dry filtercake, pounds per M.G. sewage	1300	1275	1345	1610	2350	1810	1385	2030	1800	1145	2240	2200	20490	1710	2350	1145
Wet filtercake, 1000 pounds per day	4.2	5.4	6.2	6.7	13.6	13.4	9.3	10 9	9.6	6.9	10.6	7.3	104.1	8.7	13.6	4.2

daily. The collecting mechanism is run for an hour prior to drawing, and at no other time.

Sludge from the secondary settling tanks is drawn once each day.

Samples of raw sewage, settled sewage, filter effluent and final effluent are taken each hour. Punch clock stations are located at each sampling point and the employe taking the hourly sample must register each trip by that method. Raw sewage sample is composited by flow.

Daily determinations of the following are made:

Ph. of the raw sewage.

Suspended solids from each sampling station, gravimetrically.

B.O.D., 5 day at 20 deg. C., from each sampling station, also stream above and stream below.

Dissolved oxygen from each sampling station, also stream above and stream below.

Nitrates in the final effluent.

Settleable solids, raw sewage, three hours.

Once each month samples of sludge in the digestion tanks are run to determine Ph. value, moisture content, ash and volatile matter. Other analyses and tests are made as need arises. A record of the volume of sewage entering the plant, screenings removed, grit removed, gas produced and weather conditions is recorded daily.

Dry sludge is taken from the beds by neighboring farmers at no cost to the city.

A record of a typical year of operation can be found in Table 1.

West Treatment Plant—Operating mechanism on the screen chamber is run once each hour. Screenings are buried daily.

Grit is removed daily.

Sludge is drawn continuously and returned continuously. Vacuum filters are operated when necessary to keep the percentage of dry solids in the aeration tank, between 0.3 and 0.4 percent by weight.

Sludge cake from the filter is put on land owned by the city or land of adjoining property owners and plowed under immediately.

Samples of raw sewage and final effluent are taken each hour. Punch clock stations are located at each sampling point and the employe taking the sample must register each trip.

Daily determinations of the following are made:

Suspended solids from each sampling station, gravimetrically.

B. O. D. 5 day at 20 deg. C., from each sampling station, also from stream above and stream below.

Dissolved oxygen, from each sampling station, also from stream above and stream below.

Nitrates in the final effluent.

Ph. of raw sewage.

Dry solids; percent in aeration tank, by weight.

Suspended solids; percent in aeration tank, by volume.

Other determinations are made from time to time as conditions demand.

A daily record is kept which shows in addition to the above, the total sewage flow, amount of air used, time filters were run, amount of ferric chloride used as sludge conditioner, weight of wet filter cake produced, and the condition of the weather.

Results

The following tables, which show results obtained during a period of one year at each of the treatment plants, have been prepared from records kept by the Division of Plants. Table I shows the results for the East Treatment Plant (separate sludge digestion-trickling filter). Table II shows the same for the West Treatment Plant (activated sludge).

Operating Costs

Tables III and IV (see page 438) give detailed information as to operating costs for each plant over a period of eighteen months. For this period each plant was running slightly under 50 percent capacity. Ln comparing costs between them it should be held in mind that the East Treatment Plant operates by gravity, while at the West Treatment Plant, sewage is pumped.

▼

To Study Regional Problems.—The University of Pennsylvania this year is offering a course of study in regional problems. It is expected that special attention will be given to cooperation in metropolitan districts where essential public services overlap governmental boundaries. Long range planning and budgeting of public works projects, city-state financial relations, expansion of county activities, annexation and consolidation and integration of government in metropolitan areas are among the subjects included in the course of study. The New York and Philadelphia regions will be studied intensively.

TABLE III—OPERATING EXPENSE, EAST TREATMENT PLANT (Sprinkling-Filters)

	Superintendence	Regular Operators	Extra Labor	Power & Light	Chemicals	Supplies	Repairs	Incidentals	Insurance	Total Cost	Gallons Treated in Thousands	Cost Per Million Gallons
1929—December	$ 100.00	$ 397.00	$ 162 83	$ 37.80	$ 100.79	$ 30 61	....	$ 4.50	....	$ 833.53	84,203	$ 9.89
1930—January	107.50	385.00	86 82	63.00	145.80	115.39	$ 1.00	5.15	....	909.66	67,400	13.50
February	107.50	364 00	83.44	92.40	99.72	32 89	....	13.50	....	793.45	57,540	13.75
March	107.50	321.00	315.23	38.05	30.16	82.00	....	4.65	....	898.59	55,530	16.20
April	107.50	356.00	496.36	53.60	17.52	66.79	....	4.65	$360.15	1,462.92	63,580	23.00
May	107.50	384 00	71.84	49.56	27.30	61.83	6.84	6.75	....	715.62	75,260	9.51
June	107.50	328.00	277.10	52.56	....	52.20	....	....	....	817.36	70,550	11.58
July	107.50	418.00	53.40	44.44	6.00	98.84	16.50	2.25	....	746.93	74,050	10.09
August	160.00	322.50	264 25	74.81	....	130.71	....	4.50	....	956.77	68.840	13 90
September	125.00	655.00	517.60	63.56	13.37	137.86	1.50	....	....	1,513.89	89,480	16.95
October	125.00	1,037.50	430.90	52.74	40.73	681.00	....	2.25	....	2,370.12	89,370	26.50
November	67.50	328.00	120.94	73.73	....	18.31	....	2.25	....	610.73	94,785	6.75
December	62.50	689.50	128.72	79.36	....	19.02	8.12	2.40	....	989.62	74,200	13.35
1931—January	62.50	261.50	65.37	49.94	....	20.13	....	5.19	....	464.63	88,260	5.24
February	62.50	356.00	131.56	75.78	....	415 38	....	9.10	....	1,050.32	52,680	19.93
March	62.50	397.00	40.39	69.88	....	27.02	....	28.74	....	625.53	63,894	9.80
April	62.50	385.00	69.00	69 69	....	103.65	....	15.25	103.70	808 79	88,020	9.17
May	62 50	384.00	99.25	59.71	....	50.44	....	104.00	....	759.90	78,150	9.58
Total	$1,705.00	$7,769.00	$3,415.00	$1,100.61	$ 481.39	$2,144 07	$33.96	$215.13	$464.20	$17,328.36	1,335,792	$238.69
Average	94.72	431.61	189.73	61.14	26.73	119.12	1.89	11.95	25.79	962.68	74,211	12.97

TABLE IV—OPERATING EXPENSE, WEST TREATMENT PLANT (Activated-Sludge)

	Superintendence	Regular Operators	Extra Labor	Power for Compressors	Power for Pumps and Filters	Lights	Repairs	Chemicals	Oils and Greases	Other Supplies	Insurance and Incidentals	Total	Thousand Gallons Treated	Cost Per Million Gallons
1930—November	$ 67.50	$ 380.00	$ 206.56	$ 577.50	$ 152.43	$23.10	$ 9.30	.....	.....	$150.11	.....	$1,566.50	21,454	$72.90
December	62.50	380.00	235.00	596.75	211.05	21.70	.....	$ 133.24	$ 54.25	.....	$ 5.30	1,699.79	29,197	58.20
1931—January	62.50	380.00	210.00	673.75	209.48	26.08	14.85	418.07	.....	41.82	42.46	2,079.01	31,661	65.70
February	62.50	426.00	293.56	633.50	184.63	22.23	.....	.....	.....	326.17	42.46	1,991.05	25,824	77.10
March	62.50	380.00	200.00	609.00	297.85	24.85	.....	.....	.....	58.20	82.53	1,714.93	39,843	42.90
April	62.50	380.00	65.00	526.75	321.13	16.10	.....	.....	10.00	97.35	57.83	1,536.66	49,253	31.18
May	62.50	380.00	98.25	595.00	299.01	15.58	48.09	.....	.....	14.73	4.20	1,517.36	46,262	32.80
June	62.50	387.50	60.00	586.25	229.95	15.23	19.90	129.28	.....	75.18	47.96	1,613.75	35,775	45.10
July	62.50	350.00	62.50	628.25	246.23	18.03	11.73	.....	16.67	46.08	17.75	1,459.74	36,703	39.75
August	62.50	350.00	100.00	624.75	271.43	20.13	7.85	.....	.....	12.48	16.67	1,465.81	41,397	35.20
September	62.50	415.00	145.00	609.00	232.23	24.68	17.60	73.33	40.00	7.65	42.46	1,669.45	31,490	53.00
October	62.50	272.25	145.00	861.00	216.13	13.13	40.55	92.99	.....	39.74	51.46	1,794.75	22,878	78.30
November	62.50	272.25	150.00	509.25	180.43	15.40	.....	67.26	.....	4.08	42.46	1,303.63	24,085	54.10
December	62.50	382.50	140.00	624.75	246.05	16.27	.....	77.11	.....	23.81	42.46	1,615.45	32,843	49.40
1932—January	62.50	413.50	201.00	449.75	228.38	1.09	14.77	39.31	14.72	.45	45.96	1,471.43	35,112	41.90
February	62.50	377.00	106.00	372.75	204.05	3.85	.....	51.49	.60	.....	45.96	1,224.20	34,414	35.70
March	62.50	470.00	175.00	507.50	231.88	4.20	33.72	208.66	.60	16.23	45.96	1,756.25	37,518	46.80
April	75.00	345.00	181.00	567.00	202.48	3.68	77.40	158.00	.....	8.36	48.98	1,666.90	37,243	44.70
Total	$1,142.50	$6,741.00	$2,773.87	$10,552.50	$4,164.82	$ 285.33	$ 295.76	$1,448.74	$ 136.84	$ 922.44	$682.86	$29,146.66	612,953	.....
Average	63.47	374.50	154.10	586.25	231.38	15.85	16.43	80.49	7.60	51.25	37.94	1,619.26	34,053	$47.55*

*Includes $6.80 per M. G. pumping cost.

Cost of Water Purification at St. Louis, Mo.

The following note is taken from the annual report of the Water Commission of St. Louis, Mo., for the year ending April 11, 1932:

The report covers the work done and the results obtained by the purification plants at the Chain of Rocks and Howard Bend.

The total amount of water consumed during the year was 42,399.2 million gallons, the lowest amount since 1928. The total cost of purification was $433,276.57, or an average of $10.22 a million gallons. This cost is $0.66 less than for the previous year and is due entirely to savings effected in chemicals. The total amounts and costs of chemicals used at both plants are as follows:

	Tons	Cost
Lime	16,469.00	$133,515.29
Aluminum Sulphate	2,416.00	43,019.30
Ferrous Sulphate	1,284.00	16,948.46
Ammonium Sulphate	65.00	2,407.56
Ammonium Chloride	17.00	1,863.29
Chlorine	121.00	4,782.13

The quality of the water supplied to the consumers was improved chemically, bacterially and organoleptically. The average turbidity was 0.13 p.p.m., the average bacterial count was 10 per ml. and the number of B. Coli per 100 ml. was 0.018. Taste complaints were unusually few. The average hardness was 85 p.p.m., the softest water ever supplied by the city.

Association Meetings Scheduled

Jan. 16-18—American Society Municipal Engineers. Annual Convention, Detroit, Mich. Executive Director, C. W. S. Sammelman, 4359 Lindell Blvd., St. Louis, Mo.

Jan. 16-19—Texas Water Works Short School, Temple, Texas. V. M. Ehlers, Secretary, % State Dept. Health, Austin, Texas.

Jan. 17—New York State Sewage Works Association. Hotel McAlpin, New York City. A. S. Bedell, Secretary, % State Dept. Health, Albany, N. Y.

Jan. 18-21—American Society of Civil Engineers. Annual Meeting. Engineer Societies Building, New York City. George T. Seabury, Secretary, New York City.

Feb. 9-11—Kentucky-Tennessee Section American Water Water Works Association. Brown Hotel, Louisville, Ky. F. C. Dugan, Secretary-Treasurer, 532 West Main St., Louisville, Ky.

March 22-24—Canadian Section of the American Water Works Association. Hotel Chateau Laurier, Ottawa, Ont. A. E. Berry, Secretary, % Ontario Dept. of Health, Toronto, Ont.

June 12-16—American Water Works Association. Annual Convention. Hotel Sherman, Chicago, Ill. Beekman C. Little, Secretary, 29 West 39th St., New York City.

Letter to the Editor

Dear Sir:

In the report of the meeting of the New York State Sewage Works meeting, appearing in the November issue of WATER WORKS AND SEWERAGE, I am reported as stating that "Digested Sludges have required 5 lbs. of ferric chloride and 15 lbs. of lime to each 100 lbs. of dry solids when dewatering on Oliver type vacuum filters."

If I so stated I misrepresented the facts, because with *digested* sludges no lime was required. With *crude* (undigested) we have found the use of lime in addition to ferric chloride to be essential. The latter also applies to mixed crude and activated sludge *after digestion.* I believe a statement should appear in WATER WORKS AND SEWERAGE to correct any erroneous impression that might have been conveyed that ordinary digested sludges require lime in addition to ferric chloride.

E. D. FLYNN,
Oliver United Filters, Inc., New York City.

EDITORIALS

WE FAVOR:

1. No diversion of water works revenues.
2. Laws permitting a city to issue "revenue bonds" for water works or sewerage improvements.
3. The passage of a "sewer rental law" in every State similar to that in Michigan.
4. Universal metering.
5. Universal treatment of water to secure not merely elimination of harmful bacteria, but freedom from hardness, odors and bad tastes.
6. Cessation of stream and lake pollution.
7. The pension system for municipal employees.
8. Licensing of consulting engineers and of operators of water and sewage treatment plants.
9. Periodic employment of consulting engineers to diagnose any economic troubles and prescribe the cures.
10. Elimination of "politics" from the construction and operation of water works and sewer systems.

The Cost of Obsolescence

INDUSTRIAL plants facing competition, as they must, can not afford to operate antiquated mechanical equipment. Why should municipalities continue to use a piece of obsolete equipment merely on the strength of the fact that it has not served its expected useful life, or for the reason that it continues to operae at an efficiency not far below that obtained when the equipment was first installed? There is but one answer: they should not, but they too frequently do.

In an industrial plant it is the job of the superintendent or the chief engineer to recommend the removal of any piece of equipment in the plant, regardless of its physical condition, as soon as it becomes obsolete. In such instances a machine, pump, motor or other appurtenance is considered to be obsolete whenever a new piece of equipment is developed, or an existing one is improved upon, to an extent that the reduced cost of operation effected by the replacement and new expenditure will more than offset the cost of scrapping the existing unit. Inasmuch as the seller usually guarantees improved performance and definite reductions in operating costs, the buyer is not speculating. Manufacturers and competing utility companies frequently replace but little used equipment with new equipment and reduce net production costs thereby which shortly pay for the replacement. All that the directors are interested in are results and that should be the attitude of city councils, mayors and commissioners when it comes to giving water works superintendents authorization to purchase new equipment which will assuredly result in reducing operating costs over a period of years. A progressive superintendent can frequently do much to cut operating costs, and thereby the net production costs, if he will merely look into the matter of replacement of obsolete equipment. Having satisfied himself that it can be done it should not be difficult to secure approval of the city manager, or a city council and mayor. Even though turned down in his recommendations, he is no less a wideawake manager and in the course of time receives recognition—if not in the city at present employing him, then in another and more progressive city. It is that sort of superintendent that privately owned water companies and operating corporations are looking for. Likewise a superintendent of this caliber becomes known by water works equipment men as a "go-getter" and if not appreciated by his present employers finds very little difficulty in making a change to his advantage.

In the fields of water works and sewerage, power consumed for pumping is a major item in the cost of operation and therefore most superintendents appreciate the importance of keeping a continuous watch for any change in pumping efficiencies. In addition, every superintendent should satisfy himself that the pumping equipment in use has not been superseded by something of more advanced design and less costly to operate from the standpoint of power or labor. Improvements in pumping equipment have been marked during the past five years as pointed out by Mr. H. P. Binder in an article on the subject of "Economical Replacement of Pumping Equipment," which is printed elsewhere in this issue. Furthermore, he also calls attention to the fact that reliable pump manufacturers stand ready to make a study and recommendation covering the pumping problems of a city, with the possibility of proving that operating costs can be reduced to a degree warranting a change in pumping facilities, frequently entailing but slight and inexpensive procedures.

Mr. Binder presents impressive case records to indicate how and where revamping or replacement of pumping equipment has reduced pumping costs. In a small town new deep-well pumps had effected a 30 per cent reduction in pumping costs, amounting to $34.10 per million gallons. In a larger city the saving had amounted to $9,791 the first year, whereas the installation had cost but $4,700. Clearing a "profit" of $5,000 during the first year, after having written off the cost of the new equipment, was no mean accomplishment. At Waycross, Ga., a $12,000 replacement has reduced annual operating expenses by almost $6,000. The $12,000 initial expenditure probably loomed large in the eyes of the city council of Waycross, but it must have been very pleasing to them to have $6,000 less to pay out for power and labor during the first year of operation.

It is certain that the three cities above referred to were paying a high price for the operation of obsolete pumping equipment and there are a large number of similar opportunities to replace other obsolete water works equipment with profit. The high cost of operating obsolete pumping equipment is being more heavily felt by small municipalities than by large ones, notwithstanding the fact that small installations are the most simple to diagnose and correct.

The Reconstruction Finance Corporation has, through its director, Mr. Harvey C. Couch, called attention to the fact that "funds will be advanced for eligible small projects just as readily as for large ones." With the ease with which it can be shown that replacement of obsolete equipment (pumps and motors in particular) will meet the requirement that the project be self-liquidating in character, a loan for such a betterment would be very promptly forthcoming from the R. F. C. It is

believed that the Engineering Advisory Board of the R. F. C. will welcome numerous applications for such aid. Small loans serve to spread the funds over a wide area and being used to bring about a reduction in operating expense, will at the same time produce that which is being demanded by tax payers—viz., reduced governmental and municipal operating costs.

▼

Will Science Dispel the Depression?

Many thinking people are of the opinion that scientific developments will dispel the depression. For instance, Dr. H. M. Tory, president of the National Research Council, Ottawa, Canada, recently said in a speech, that one great fundamental discovery, such as that made by Michael Faraday in electricity 100 years ago, would do more to dispel the depression than the combined work of all the economists and politicians of the world.

Merchandising organizations have learned that the salability of products or processes now depend entirely upon the novelty of the production. The demand is for something different, preferably with a dash of the scientific. Even the voters in the recent presidential election demanded something new.

In the water works field we have the example of the amazingly rapid increase in the use of a new product in that field—activated carbon. The demand for this product has probably been sufficient to keep a parent industry out of "red ink" during the past two years.

In the sewage treatment field the novelty idea is exemplified by the developments in chemical processes for sewage and industrial waste purification. The demand of municipal officials confronted with a sewage problem seems to be for something new or different from the commonplace processes. Whether this be because of the shortcomings of the orthodox processes or whether it be largely a psychological matter is not known. Probably it is a combination of both.

There is apparently much to Dr. Tory's diagnosis. A few more cellophanes, activated carbons, chronoflow meters, flocculators or another "Gulper" or two, if placed on the market, may bring us out of the depression yet.

L. H. Enslow

▼

Why Clouds Float

THE ancient Greeks thought that cloud droplets floated in the air because they were hollow. When modern research disclosed that fog droplets are not hollow, the flotation of clouds was explained by assuming that ascending currents of air counterbalanced the gravitation pull. That explanation fails in the case of fog in quiet air, and it fails in the cost of most clouds.

It is known that electrons tend to condense atmospheric moisture, and thus become nuclei of fog droplets and of rain drops. The earth's surface is charged with electrons. Hence it follows that electric repulsion exists between the electrons in fog and cloud droplets and the electrons in the earth. We infer, therefore, that electric force explains why clouds float.

The earth is known to be encased by several electron shells at great altitudes. By assuming the existence of several more such shells at low altitudes, it becomes possible to explain the tendency of clouds to form in strata.

Clayton ("World Weather," p. 168) gives the following mean heights of different classes of clouds at Blue Hill, Mass.

Alto-Cumulus	2,497	meters
Alto-Stratus	2,263	meters
Cumulus	1,380	meters
Strato-Cumulus	1,084	meters
Stratus	713	meters
Nimbus	704	meters

Kite flights have shown that the velocity of the air in a cloud stratum is greater than between such strata. We can explain this by the electron-shell theory, for such shells receive magnetic rotation in the presence of the earth's magnetic field.

Incidentally this magnetic rotation theory may serve also to explain the eastward movement of air in temperate and frigid zones, and the westward movement in tropical and torrid zones. The planet Jupiter discloses several rather sharply bounded zones in its atmosphere, whose rates of rotation differ. A well marked "spot" in one may sail by that in an adjacent zone at the rate of 200 miles an hour. Magnet rotation would produce such a phenomenon, provided that electrons were present in different numbers per unit of volume in different zones. A similar difference would occur were the density of electrons constant but were that of protons different in adjacent zones; for the protons would act oppositely to the electrons, and would serve as brakes upon the rotation of the zones. If, then, the earth's lower atmosphere contains relatively more protons near the equator than near the poles, their braking effect may be such as to cause the equatorial air to lag behind the earth's rotation and thus produce the trade winds of that region. The convection current theory of air movement fails to explain this difference in velocity of the air relative to the earth in different zones, in spite of many ingenious attempts to wring an explanation from it by aid of supplementary hypotheses.

When a drop of water is broken into two drops of different size, the smaller drop is found to be charged with negative, and the larger drop with positive electricity. This suggests that a drop of apparently uncharged water may really be charged with positive protons at its nucleus and an equal number of negative electrons forming a shell in its surface. If so, this may throw light on the curious fact that hailstones are often laminated, shell upon shell, like an onion.

There are numberless phenomena in the realm of meteorology that are very puzzling until the modern electron theory is invoked. Yet, singularly enough, very few meteorologists have given more than a passing thought to the electron theory as an aid in solving their problems. On the contrary, even so studious a meteorologist as Clayton brushes aside the electron theory on the second page of his book and mentions it only a few times afterward. He says: "The one form of energy that experiment and experience show to be adequate to cause atmospheric disturbance is heat." Yet later on he concedes that very little is known as to the frictional retardation that occurs when air moves across the earth's surface. If a hydraulic engineer were to say that he could determine the velocity of water in a pipe without knowing the frictional resistance, he would be just as wrong as is Clayton in his belief that he can explain air movement solely on a convection hypothesis. Similarly the convection theory is defective when he uses it to explain why clouds float, for it fails to explain why fog floats. Undoubtedly updrafts of air help to support clouds, but many a cloud exists where no updraft can be detected.

W. P. Gillette

SIMPLEX

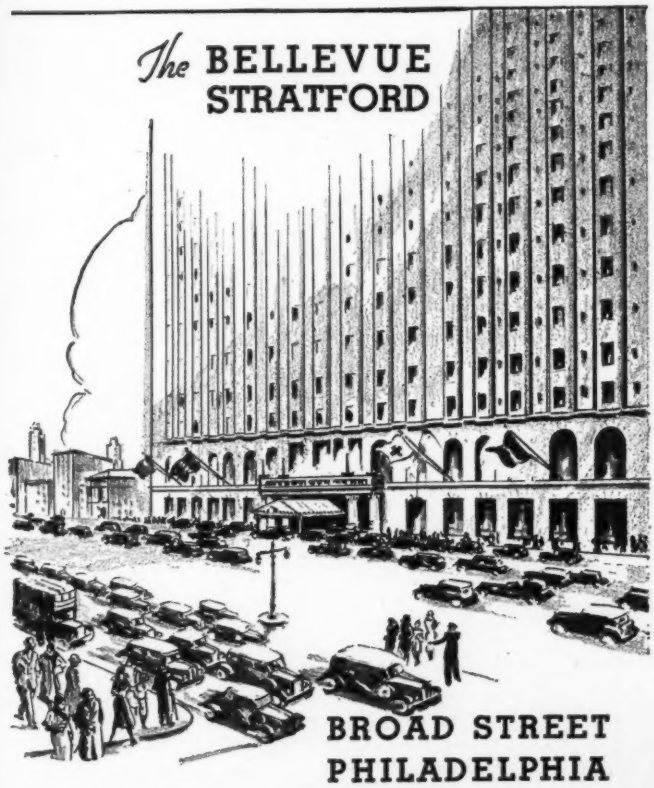
Simplex Indicating Recording Totalizing Meter Register

Venturi Type Meters
Effluent Controllers
Filtration Plant Gauges
Water Works Specialties

WRITE FOR BULLETINS

SIMPLEX VALVE & METER CO.
6743 Upland Street
Philadelphia, Pa.

The BELLEVUE STRATFORD



BROAD STREET
PHILADELPHIA

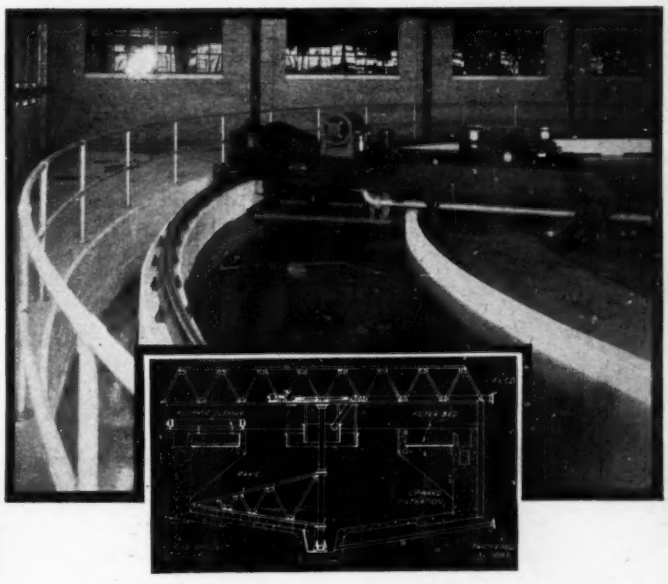
. . at the Bellevue-Stratford—center of the important social and business life of the city. You will enjoy the fine atmosphere and perfect attendance of this world-renowned hotel—and will appreciate rates that are consistent with present times.

CLAUDE H. BENNETT, *General Manager*

FILTRATION EQUIPMENT CORPORATION

LAUGHLIN CLARIFYING TANK

For the Better Removal of Suspended Solids from Sewage and Industrial Wastes



—Permits of usual sedimentation and thickening operations within a tank, at high capacity for a given tank size.

—Removes solids by positive filtration.

—Filter bed embraces entire circumference of tank, extending inwardly five feet or more.

—Operated with a traveling magnet which cleans the filter bed as necessary.

—Tanks of round or rectangular type for any capacity.

—Low power and low operating cost.

FILTRATION EQUIPMENT CORPORATION
350 MADISON AVE. NEW YORK

WATER WORKS SUPERINTENDENT—22 years' experience in operation and management of water works. Seventeen years as superintendent in metropolitan area of 50,000 population, in charge of three separate water works systems. Experienced in managing water softening and deep well supplies, including location and drilling. Salary secondary consideration. Age 46. Address "F. E. S.," % Water Works and Sewerage, 420 Lexington Ave., New York City.

FILTER PLANT CHEMIST—Position desired as superintendent, chemist or operator in a water purification plant. I have had five years' experience as a chemist in a large filter plant and have had four years' work as superintendent of a small plant. Holder of state license. Would be able to combine operating and laboratory work if necessary. Address "N. T. E.," Water Works and Sewerage, 400 W. Madison St., Chicago, Ill.

CIVIL AND SANITARY ENGINEER—Registered; B. S. in civil engineering; over 22 years' experience with the investigation, design, actual construction, purchase and installation of equipment, appraisal, estimating and operation of water supplies, filtration plants and sewage disposal works. The last eight years' work includes the design, construction and operation of sanitary works in Europe. References and details of experience may be had upon request. Age 45. Address "L. A. G.," % Water Works and Sewerage, 420 Lexington Ave., New York City.

SANITARY ENGINEER-CHEMIST — More than 20 years' experience in all phases water purification, sewage treatment and industrial wastes and stream pollution investigations. Experience in actual plant operation and special experience and accumulated data on industrial wastes and sewage treatment. For eleven years in charge of water supply, sewage and stream pollution work for one of the more active of State Health Departments. Permanent or temporary work desired. Address "G. C.," % Water Works and Sewerage, 420 Lexington Ave., New York City.

POSITIONS WANTED

This department has been started as a service to those in the Water Works and Sewerage Fields. We hope they will make use of it. The notices are inserted without charge.

REGISTERED CIVIL ENGINEER—Seven years' experience in sanitary and municipal work, including sewer design and construction, water main construction, surveys for reports and impounding reservoirs, drafting and some design on water purification and sewage treatment plants. Age 32, married, B. S. in structural and municipal engineering, Junior Member eligible for Associate Member A. S. C. E. References on request. Available immediately. Address "O. H. S.," % Water Works and Sewerage, 400 W. Madison St., Chicago, Ill.

CIVIL ENGINEER—Age 27. I. C. S. graduate. 10 years' experience in sewerage and highway work. Resident engineer on several large sewer contracts. Good draftsman. Location immaterial. Excellent references. Address "A. J. G.," % Water Works and Sewerage, 420 Lexington Ave., New York City.

SUPERINTENDENT OF PURIFICATION or control chemist, or a combination of the two, in a small or medium sized plant. Technically educated in hydraulic water supply, water purification, water softening and chemistry. Will contract the operation and supervision of a small or medium sized plant. Employed at present and for the past eight years as superintendent and control chemist of small plant. Address Box 3000, % Water Works and Sewerage, 400 W. Madison St., Chicago, Ill.

CIVIL ENGINEER — 28, technically educated, with nine (9) years of practical experience, five (5) in municipal and federal water works construction. Desires to make connection in or around New York City. Reply to "W. F. S.," % Water Works and Sewerage, 420 Lexington Ave., New York.

ENGINEER-SUPERINTENDENT—B. S. in Sanitary Engineering. 13 years experience in operation of large and small sewage treatment works and experimental sewage treatment, activated sludge, Imhoff tanks, sprinkling filters, pressing, filtering and heat drying of sludge. Married. Age 34. Address "R. S. S.," Water Works and Sewerage, 400 W. Madison St., Chicago, Ill.

SANITARY CHEMIST—Twelve years' experience in operation of large and small sewage treatment plants. Experienced in water purification, boiler feed water treatment, also treatment of industrial wastes and stream pollution investigations. For nine years chemist in charge of sewage treatment in city of more than 300,000 population. Permanent or temporary position desired. Address "W. R.," % Water Works and Sewerage, 420 Lexington Ave., New York City.

CONSTRUCTION ENGINEER — Twenty years' experience in water purification and sewage disposal, the last ten having been spent in the field with broad experience on both small and extra large jobs as resident engineer or superintendent for contractors. Desire position with either consulting engineer or contractor who go after big jobs. Location immaterial, but salary a consideration. Address "E. B. A.," % Water Works and Sewerage, 400 W. Madison St., Chicago.

ARTESIAN WELLS—Engineer specializing in the construction and development of sub-surface water supply resources desires an engagement to supervise operations of this character. Have knowledge of all modern drilling methods; also extensive experience with projects of major importance, both domestic and foreign; location immaterial. References submitted on request. Address "M. S. J.," % Water Works and Sewerage, 420 Lexington Ave., New York City.

ASSISTANT CIVIL ENGINEER—Age 26. Single. Newark Tech. graduate. 7 years' experience. Assistant engineer on highway and sewer work. Sewer inspector. Able draftsman. Stenography and typist. Location immaterial. Address "J. D. S.," % Water Works and Sewerage, 420 Lexington Ave., New York City.

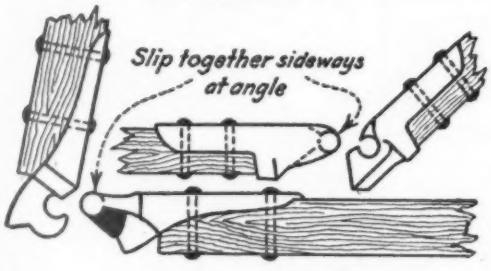
STEWART SEWER CLEANING MACHINE

Water Cleaning System, if you wish it, or Drag Bucket type.

WE WILL PAY FREIGHT AND CHARGE TO BILL.

We Ship Rods for Trial—who else will do this?

We also make a Rod that will float. Also rods with wheels for conduit work.



SEWER AND CONDUIT RODS

No Deep Shoulder Cut for Couplings. Rods retain full size and strength.

Investigate our JUMBO ROD

W. H. STEWART

1614 Locust Street . . . . . ST. LOUIS, MO.
129 George Street . . . . . BOSTON, MASS.
Box 581 . . . . . JACKSONVILLE, FLA.

CANADA FACTORY, WALKERVILLE, ONT.
Therefore No Duty for Purchaser to Pay

PACIFIC COAST DELIVERIES MADE FROM SAN FRANCISCO

What Hotel in Chicago ? Offers..

- RADIO LOUD SPEAKER *In Every Room*
- RUNNING ICE WATER *In Every Room*
- TUB BATH OR SHOWER *In Every Room*
- GARAGE · *With Direct Entrance to hotel*

RATES
$2.00 .:. $2.50 and $3.00 Single

HOTEL HARRISON

HARRISON STREET
(JUST OFF MICHIGAN BOULEVARD)

RUSSELL A. WAAS, Manager — ANDREW C. WEISBURG, President

ILLUSTRATED BOOKLET SENT ON REQUEST

Yes—we would like you to mention WATER WORKS AND SEWERAGE.

Cast Iron Pipe

Bell and Spigot type
Sand Cast
Long Lengths

McWane Precalked Joints or Open Bell
Sizes: 1¼ thru 12 inches. Fittings.

McWANE CAST IRON PIPE CO. BIRMINGHAM ALABAMA

PACIFIC STATES CAST IRON PIPE CO. PROVO, UTAH

New York Chicago Kansas City Los Angeles
San Francisco Denver Portland, Ore. Dallas
Salt Lake City

CLEARING HOUSE

20% off—Rebuilt Transits and Levels

Best selection in United States. Every Instrument overhauled in our own factory. Sold subject to field test. Convenient payment plan. Your old instrument taken in trade. Write for our list (WSC612).

WARREN-KNIGHT CO.
Makers of Sterling Transits and Levels
136 N. 12th Street Phila. Pa.

News!

The editorial columns provide you with new methods and practices in use by others in your field.

But the advertisements are no less important for they keep you informed of advances in equipment and machinery that mean savings in construction costs.

READ THE ADVERTISEMENTS!

THE SURVEYOR
and Municipal and County Engineer

has been established for 40 years and is known throughout the world as the chief authority on *Roadmaking, Sewerage* and all other *Municipal Work.*

Advertisers regard it as an excellent medium for attracting business and public authorities use its columns to make known their requirements.

Published every Friday, price 12 cents.
Annual Foreign Subscription, 8 dollars.

A specimen copy sent free upon application to the publishers,

ST. BRIDE'S PRESS, Ltd., 14 Bride Lane, Fleet Street, London, England

ROBERTS
FILTER MANUFACTURING CO.
607 Columbia Ave., Darby, Penna.

Manufacturers of Pressure and Gravity Type Water Filters and Specialties for Water Purification and Sewage Treatment Plants.

We contract for complete installation of mechanical and hydraulic equipment in all forms of Water Filtration Plants, Sewage Disposal Plants and Pumping Stations.

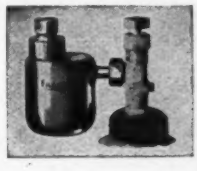
Write us concerning your Sanitary Problems.

THE NATIONAL METHOD
of Water Main Cleaning
20 Years Experience
Write for Booklet
"The Cleaning of Water Mains"
National Water Main Cleaning Co.
32 Church St. New York

A FILCLORATOR FOR

Assures the efficient operation of your gas control apparatus by delivering clean gas uninterruptedly to the metering orifices. Prevents clogging also necessity for blowing off tanks. Pays for itself. Circular on request.

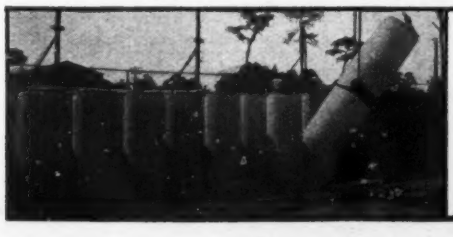
WATER, SEWAGE, INDUSTRIAL PLANTS, SWIMMING POOLS



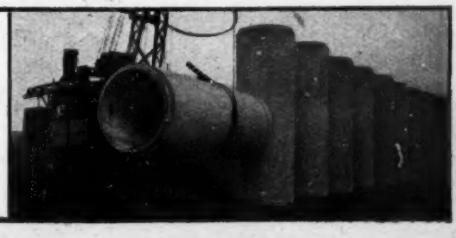
THE FILCLOR COMPANY
Commercial Trust Bldg.
Philadelphia Penna., U. S. A.

STREET, SEWER AND WATER CASTINGS

Made of wear-resisting chilled iron in various styles, sizes and weights.
Write for Catalog and Prices
SOUTH BEND FOUNDRY CO.
All Kinds of Gray Iron Castings SOUTH BEND, INDIANA



LOCK JOINT
Reinforced
Concrete Pipe
PRESSURE - SEWER - CULVERT
Lock-Joint Pipe Co., Ampere, N. J.



DIRECTORY OF ENGINEERS

Alvord, Burdick & Howson

Engineers

John W. Alvord, Charles B. Burdick, Louis R. Howson, Donald H. Maxwell.
Water Works, Water Purification, Flood Relief, Sewerage, Sewage Disposal, Drainage, Appraisals, Power Generation.
Civic Opera Building, Chicago.

Black & Veatch

Consulting Engineers

Sewerage, Sewage Disposal, Water Supply, Water Purification, Electric Lighting Power Plants, Valuations, Special Investigations, Reports and Laboratory.
E. B. Black, N. T. Veatch, Jr.
Kansas City, Mo., Mutual Bldg.

H. Burdett Cleveland

Consulting Sanitary Engineer

Water Supply and Purification, Sewerage and Sewage Disposal, Refuse Disposal, Treatment of Industrial Wastes, Design, Reports, Consultation, Investigation, Evaluation of Works, Supervision of Construction.
Transportation Building.
225 Broadway, New York.

Burns & McDonnell Engineering Co.

McDonnell-Smith-Baldwin-Lambert

Consulting Engineers

Waterworks Sewerage
Lighting Appraisals
Rate Investigations
Kansas City, Mo., Interstate Bldg.
Los Angeles, Cal., Western Pacific Building.

Chicago Testing Laboratory, Inc.

and affiliated

Chicago Paving Laboratory, Inc.

Consulting and Inspecting Engineers

Hugh W. Skidmore
Gene Abson
Materials, Processes, Structures, Consultation, Inspection, Testing, Design, Research, Investigation and Experts in Litigation.
536 Lake Shore Drive, Chicago.

The J. N. Chester Engrs.

J. N. Chester
J. F. La Boon
D. E. Davis
J. T. Campbell
E. B. Bankson
Consulting Hydraulic, Sanitary and Valuation Engineers.
Pittsburgh, Pa., Clark Bldg.

H. O. Chute

Chemical Engineer

Stream Pollution and Trade Waste Problems Handled from the Standpoint of Recovery of Products. Specialist in Multiple Effect Evaporation.
50 East 41st Street, New York City.

Clark, Wm. G.

Civil and Sanitary Engineer

Hydraulic, Sanitary and Municipal Engineering, Power Developments, Expert Examinations and Reports.
Toledo, O., 1046 Spitzer Bldg.

A. W. Dow

Chemical Engineer
Consulting Paving Engineer

A. W. Dow, Ph. B., Mem. Am. Inst. Ch. Engrs.
Asphalt, Bitumens, Paving, Hydraulic Cement, Engineering Materials.
131-3 E. 23d St., New York City.

Fowler, Charles Evan

Consulting Civil Engineer

M. I. Am. C. E.
M. Eng. Inst., Can.
BRIDGES AND ARTISTIC STRUCTURES.
FINANCING FOR GOOD PROJECTS.
New York City.
5 West 63rd St.

Fuller & McClintock

Engineers

George W. Fuller
James R. McClintock
F. G. Cunningham
C. A. Emerson, Jr.
Elmer G. Manahan
W. Donaldson
E. W. Whitlock
Water Supply, Water Purification, Sewerage, Sewage Disposal, Garbage and Industrial Wastes, Valuation and Rate Regulation of Public Utilities.
New York, 170 Broadway.

Gascoigne, George B.

Consulting Engineer

W. L. Havens A. A. Burger
F. W. Jones F. C. Tolles
Sewerage and Sewage Disposal, Water Supply and Purification, Treatment of Industrial Wastes.
Cleveland, Leader Bldg.

Gordon & Bulot

Engineers

Successors to Maury & Gordon.
Water Supply and Purification, Sewerage and Sewage Disposal.
Design, Appraisals, Reports.
Chicago, 53 W. Jackson Blvd.

Hall, B. M., & Sons

Civil, Mining and Hydraulic Engineers

Southern Water Powers
Drainage
Irrigation
Atlanta, Ga., Peters Bldg.

Nicholas S. Hill, Jr.

Consulting Engineer

Water Supply, Sewage Disposal, Hydraulic Developments, Reports, Investigations, Valuations, Rates, Design, Construction, Operation, Management, Chemical and Biological Laboratories.
112 East 19th St., New York

A. Elliott Kimberly

Consulting Sanitary Engineer

Water Supply, Water Purification, Water Softening, Sewerage, Sewage Disposal, Sewage Treatment, Waste Treatment, Specialists in Milk and in Canning Waste Treatment.
568 East Broad St., Columbus, Ohio.

Morris Knowles, Inc.

Engineers

Water Supply and Purification, Sewerage and Sewage Disposal, Valuations, Laboratory, City Planning.
Pittsburgh, Pa.

Metcalf & Eddy

Engineers

Water, Sewage, Drainage, Refuse and Industrial Wastes Problems, Laboratory, Valuations.
Statler Bldg., Boston.

Sheppard T. Powell

Chemical Engineer

Treatment of Water for Industrial Uses.
Trade Waste Investigations and Correction.
Technical Expert in Litigations.
213 St. Paul Place, Baltimore, Maryland.

Potter, Alexander, C. E.

Hydraulic Engineer and Sanitary Expert

Sewerage and Sewage Disposal, Water Supply and Purification.
New York, 50 Church St. Cortlandt 3195.

Malcolm Pirnie

Engineer

Malcolm Pirnie,
Charles F. Ruff.
Water Supply, Treatment, Sewerage Reports, Plans, Estimates.
Supervision and Operation.
Valuation and Rates.
25 W. 43rd St., New York, N. Y.

Randolph-Perkins Co.

Consulting Engineers for

Water Supply and Distribution.
Sewerage and Sewage Disposal.
Street Lighting Systems.
Zoning and City Planning.
Water Power Development.
Flood Protection.
Excavation Specialists.
Stripping Properties Prospected.
8 East Huron St., Chicago.

Astrid S. Rosing, Inc.

Sewer Pipe.
Drain Tile.
Steam and Electric Conduits.
Building Tile.
Fire Brick.
3464 N. Clark St., Chicago, Ill.

P. H. Taylor Audit Co.

Municipal Accountants and Auditors

Audits.
Systems.
Budget Preparation.
Investigations.
267 Highland Ave., Buffalo, N. Y.

Dorrco Doings in 1932

The mental confusion, caused by the events of the past year, is the outstanding feature of the present outlook of most of us. Many explanations have been offered for present conditions and many means have been advanced for overcoming them. These range all the way from the cancellation or reduction of all debts, both international and national, to Technocracy and its demonstration of the enormous and geometrically increasing growth of power per capita in the last hundred years and the great opportunity it offers if we can effect a proper distribution of the material benefits which may be had with a small amount of labor.

Pupin suggested last winter that, since the discovery of certain physical laws and their application had led to the enormous technical developments of our present civilization, we should now search just as diligently for some spiritual laws which would overcome the twin evils, Hate and Fear, which are the root of the world's present unhappiness and suffering. "Profits or Prosperity," the title of a recent most incisive analysis of present conditions, is in itself most thought provoking.

Does not the way out depend on our recognition of the real reason why we do things—to justify ourselves to ourselves—and on our realization that financial gain, which so many of us have thought to be the mainspring of our civilization, is only one of a number of means to such justification? The scientist already knows this and regards money only as a means to an end.

The really successful man is the one who values his accomplishments for himself or others as the real thing and accepts the financial returns as only valuable insofar as they supply his needs or serve as a recognition of his accomplishments. From this viewpoint, those of us who individually or corporately have held our heads above water may perhaps feel we have been more "successful" than we thought.

SANITARY ENGINEERING

The mechanization of this field has continued, with much development done in improving existing equipment and in meeting new demands.

The Sifeed Clarifier, in both square and round tanks and employing either traction drive or a drive supported on a central column, meets new demands with notable installed savings.

The Type K Digester, a new unit, is now equipped with a central supporting column and a self-contained drive unit, thus dispensing with the unsightly superstructure formerly used. We are planning to extend present sizes to diameters of 100 feet and possibly beyond.

The Dorrco Aerator, brought out as our sixth step in mechanization after several years experimental work, combines mechanical means of maintaining sludge in suspension with diffuser aeration. This materially reduces the total power required for activated sludge treatment and allows regulation of the air to meet changing conditions.

It is interesting to know that a similar problem in cyaniding gold ores was met some years ago by the Dorr Agitator which largely displaced both air and mechanical agitators for the same reasons.

The Dorrco Distributor, also a new type, has this year been developed for trickling filter treatment.

WATER PURIFICATION

Continuous sedimentation with Dorr equipment has long been standard in this art, both for the removal of silt and chemical precipitate. It has been merely an extension of our experience and viewpoint that has led to the development of a mechanical flocculator.

The Dorrco Flocculator was originally operated longitudinally, but, to meet special requirements at one plant where long coagulation basins were already installed, a further development, resulting in transverse operation, was made with the cooperation of the engineer in charge. At this plant, the flocculators brought about a maximum utilization of chemicals, making a saving of one grain of alum per gallon or $1,400 monthly in chemicals alone. Improvements made in the floc structure have saved much in filtering costs.

CLASSIFICATION

Continuous leadership in one field for twenty-five years can only be maintained by intensive work and the intelligent utilization of broad experience.

This year the *Critical Size Control* has materially improved bowl classifier operation while recent tests at one overloaded gold mill showed that our automatic *Closed Circuit Grinding Control*, continuously controlling the rake load, increased primary grinding capacity 15 per cent or more.

The Dorr FX Classifier has this year raised our 1928 peak of 3000 tons rake load per day to 12,000 tons—1000 tons of sand per foot of rake width. Operating in closed circuit with an 8'x12' ball mill it overflowed 1200 tons per day of 35 mesh product and increased the ball mill's capacity 30-40 per cent.

With the aid of type F Bowls in the secondary circuit, a 100 mesh product was made in this mill section at less cost than the former 65 mesh product and a 4 per cent greater copper extraction was secured.

AGITATION AND PULP REFINING

Among the new things undertaken this year are the Turbo Mixer, for high-speed, mechanical agitation, and the Wiener Refiner, used in the paper industry in place of jordan engines for refining stock. Both are justifying our expectations and proving valuable additions to our line.

DORR-OLIVER

Coordination has resulted in placing the European interests of both companies under unified management and in the use of joint offices and agencies elsewhere when possible.

ENGINEERING

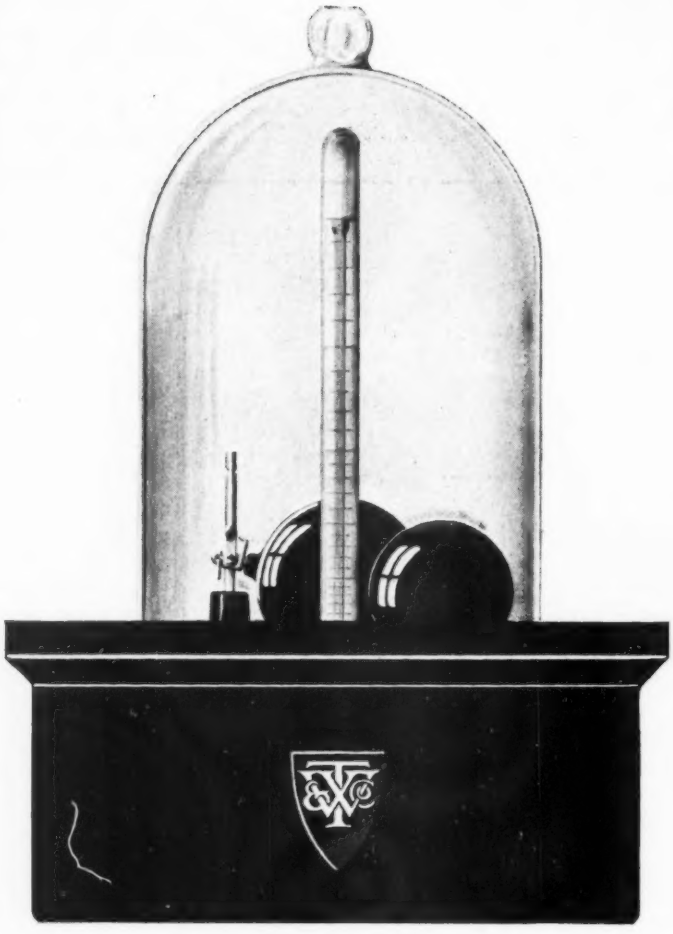
Two plants for binding fixed nitrogen have been completed during the past year, and, as with all pioneer work, much has been learned and some tools developed that promise a wider application.

In common with the trend in capital goods production, the past year has been a difficult one for our company and we go into 1933 with reduced staff and incomes, but never has our faith been greater or our "will to do" less hesitant. For all of us, I give best wishes to friends scattered over the world and say, in the language of the Unemployment Relief Fund posters, "We will see it through."

John V. N. Dorr

247 Park Ave., New York

DORRCO



DON'T PLAY HIDE AND SEEK WITH TROUBLE

It's the unseen, unknown trouble that eventually develops into a serious difficulty. That's just as true of chlorinators as it is of any other equipment. But—there is no need of your playing hide and seek with trouble in W&T Visible Control Vacuum Chlorinators because the working parts are under the glass bell jar—always in plain sight.

That's one reason why annual maintenance costs average less than 1%.

Technical Publication 38 describes visible control chlorinators in detail. Ask for a copy.

WALLACE & TIERNAN CO.

INCORPORATED

Manufacturers of Chlorine and Ammonia Control Apparatus

Newark, New Jersey — Branches in Principal Cities

Main Factory—Belleville, N. J.

"The Only Safe Water is a Sterilized Water"

SA-50